OIL SHALE TRACT C-b

ENVIRONMENTAL AND EXPLORATION PROGRAM

SUMMARY REPORT #4

(Through August 31, 1975)

C-b SHALE OIL PROJECT

Ashland Oil, Inc.
Atlantic Richfield Company
Shell Oil Company, Operator
The Oil Shale Corporation

United States Department of the Interior

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November 12, 1975

The attached report is the fourth of a planned series of reports from the Federal Oil Shale Lessees to the Area Oil Shale Supervisor describing progress under approved exploration and baseline data plans.

The purpose of these reports is to provide interested parties with a review of ongoing operations and a summary of the data being collected. Because of the sheer volume of data being generated, these reports should be considered as the first (overview) phase of planned data distribution. Parties interested in reviewing more detailed data on specific portions of the program should contact the Area Oil Shale Office in Grand Junction where such data will be kept on file.

We would appreciate receiving any comments or suggestions you may have concerning these reports.

Peter A. Rutledge
Area Oil Shale Supervisor

U. S. DEPARTMENT OF THE INTERIOR

PROTOTYPE OIL SHALE LEASING PROGRAM

TRACT C-b

SUMMARY REPORT #4

(Through August 31, 1975)

Submitted to:

Mr. Peter A. Rutledge
Area Oil Shale Supervisor
Conservation Division
U. S. Geological Survey
Grand Junction, Colorado

By:

C-b Shale Oil Project

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October 28, 1975

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INTRODUCTION

Summary Report #4 and Quarterly Data Report #4 cover the fourth quarter of exploration and environmental data for the first year of the Environmental Baseline Program for Tract C-b. These reports specifically cover the summer quarter of June, 1975 through August, 1975. Quarterly Data Report #4 consists of four volumes of a comprehensive compilation of data submitted to the Area Oil Shale Supervisor in Grand Junction on October 15, 1975. Parties interested in reviewing the comprehensive data may contact the Area Oil Shale Supervisor's Office. This Summary Report #4 is intended to provide the reader with a general overview and initiate the interpretation of the information included in the Quarterly Data Report #4. For a complete summary of on-Tract activities to date, reports from all four quarters must be consulted.

The 5th Quarterly Data Report and Summary Report will cover the fifth quarter of the two-year Environmental Baseline Program. In addition, it will include a section on annual summary and trends for the first year of the baseline program.

For ready reference, the reader is reminded that both outline and section numbering in Summary and Quarterly Data Reports are identical. Further, the complete data for this quarter are presented in Quarterly Data Report #4 and for in-depth study the reader is referred to that reference.

I

PRE-EXPLORATION ENVIRONMENTAL RECONNAISSANCE SURVEYS

No environmental reconnaissance surveys were conducted during this quarter. The results of previous surveys are contained in Quarterly Data Reports #1 and #2 and are summarized in Summary Reports #1 and #2.

ENVIRONMENTAL BASELINE MONITORING PROGRAMS

Although the basic data are reported under separate subsections, the Environmental Baseline Programs of Section II are not independent of each other, but are in fact all part of the same ecosystem. Separation into subsections is prudent at this stage in the program and any attempt to integrate data reporting might lead to confusion. As sufficient data are gathered for analytical purposes, interfaces between subsections become recognized and the program tends to become more systems oriented.

One of the more complex subsystems or interfaces involves the surface water, ground water, and geologic programs. These programs and their interfaces are depicted in the accompanying flow diagram (Figure II-1). The flow of each program is from left to right; interfaces between programs are shown by directed arrows to or through circles; activities are rectangles, and ovals represent inputs and outputs between phases. The interested reader may inspect the flow chart to ascertain how each program interrelates with others and contributes to the overall outputs--the Detailed Development Plan, Mine Dewatering Plan, Water Disposal Plan, and baseline data reports.

II A SURFACE WATER

II A-1 Surface Streams

During the fourth quarter, surface water samples were analyzed from five of the thirteen stations on or near Tract C-b. The locations for all thirteen stations are shown on Figure II A-1; stations where water quality data were obtained are:

U.S.G.S 0936025

0936007

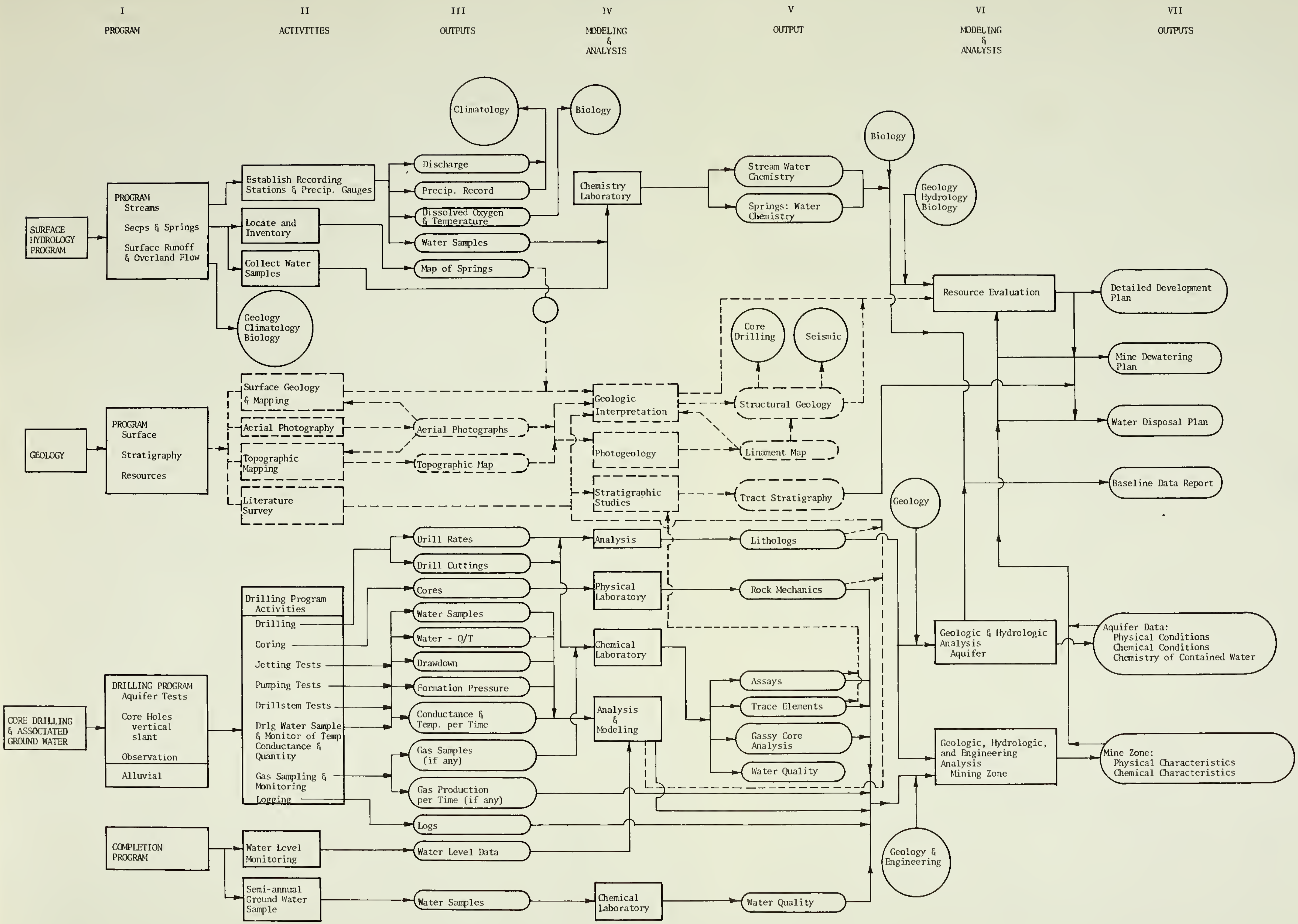
0936022

0936058

0936061

The latter four stations are located on perennial streams and are classified as major gauging stations. Station 0936025 is located on the west fork of Stewart Gulch were stream flow is ephemeral and data are obtained

FIGURE II-1
GEOLOGY/HYDROLOGY FLOW CHART



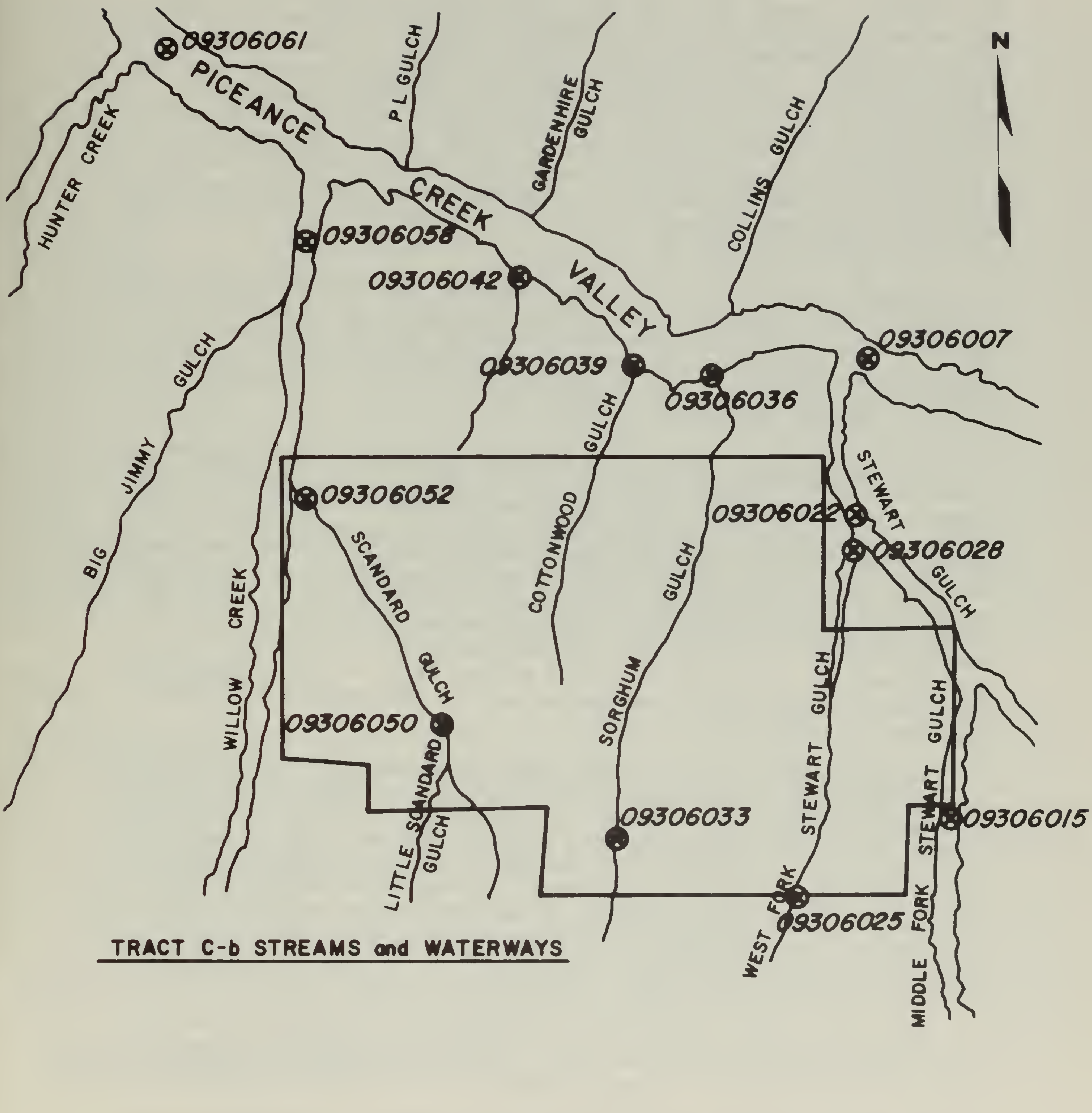


FIGURE II A-1 ⊗ SURFACE WATER GAUGING STATION

only when there is precipitation enough to cause a recordable flow. Tables II A-1 through II A-5 give a summary of water quality parameters analyzed.

Only preliminary data for the four continuous-recording stations measuring flow, temperature, pH, dissolved oxygen, and conductivity have been made available by the U.S.G.S. Daily-flow data for the perennial and ephemeral streams show that there was negligible or no flow during the period of observation in the ephemeral streams. Figures II A-2 through II A-5 are preliminary hydrographs of flow recorded at the four major gauging stations. The hydrograph patterns of Piceance Creek for upstream and downstream continuous-gauging stations are in general agreement (Figures II A-2 and II A-3). As one would expect, the flow at the downstream gauging station generally is higher than that at the upstream gauging station because of the influx of flow from tributaries. At low-flow levels, the hydrograph patterns may fluctuate because of loss of water in seepage and evaporation. At higher flow levels, these components are a minor part of the total flow.

General conclusions on the relationship of four primary water quality characteristics (temperature, pH, dissolved oxygen, and conductivity) to the flow cannot be made with the data available to date; however, continuous water temperature measurements show a marked diurnal pattern (Figure II A-6) with peaks in the afternoon and lows in the morning, as might be expected in a shallow stream.

The solubility of oxygen is a function of temperature and pressure and, since the chief source of oxygen in surface water is the atmosphere, the oxygen content of surface water and meteorological conditions are interwoven. Other factors influencing the oxygen content are hydraulic parameters, such as water chemistry and stream-bed roughness, and biological activity, such as fresh water biota or organic material load. Some oxygen is contributed indirectly as a by-product of photosynthesis. Dissolved oxygen readings are indicators of the biochemical condition of a stream. However, because of the rapidly changing conditions influencing the intake or consumption, the oxygen content of surface water is highly transient. A dissolved oxygen value is meaningful only at the sampling station and only for a brief interval of time.

Figure II A-7 shows the major ionic constituents and water hardness (yearly averages) as determined at the five gauging stations where stream flow data are available. Figures II A-8 through II A-11 show variations in the content of various ions as a function of time. All the waters are quite high in total dissolved solids (TDS), with the tributaries exhibiting higher TDS than the main stream. Magnesium and sodium are the dominant cations with sodium being dominant on the main stream, as shown at Station 007* and 061, and magnesium being the dominant cation on the tributaries, Stewart Gulch and Willow Creek. Bicarbonate is the dominant anion at all locations except the West Fork of Stewart Gulch, where sulfate dominates.

Maximum, minimum and median concentrations of selected stream water constituents based on the first complete year of data for five gauging stations are presented in <u>Summary Report #3</u>. With regard to total dissolved

* Only the 1st three digits of the station number are used in each case; e.g. 007 is U.S.G.S. Station number 09306007.

TABLE II-A-1

SURFACE WATER QUALITY
BASELINE DATA

BASELINE DATA TO BE COLLECTED SEMI-MONTHLY

STATION: U.S.G.S. No. 09306007 Piceance Creek Below Rio Blanco
February 1975 - June 1975

	2/3	2/19	3/6	3/20	4/2	4/14	5/7	5/22	6/4	7/1
1. Ammonia (mg/1) (Nitrogen)	.06	.07	.09	.03	.04	.05	.01	.01	.01	.00
2. Arsenic (ug/1)	5	1	2	4	2	3	3	2	2	3
3. Barium (ug/1)	100	<100	200	<100	<100	<100	0	100	0	0
4. Bicarbonate (mg/1)	562	602	533	450	541	481	498	390	464	557
5. Boron (ug/1)	190	220	220	220	240	190	190	110	330	180
6. Cadmium (ug/1)	0	-	0	0	0	1	0	1	0	0
7. Calcium (mg/1)	72	69	70	66	69	67	71	59	65	74
8. Carbonate (mg/1)	0	0	0	32	0	0	10	0	0	0
9. Chloride (mg/1)	19	17	15	16	15	19	18	9.0	11	15
10. Chromium (ug/1)	0	-	0	0	0	0	0	0	0	0
11. Color (PCU)	3	-	20	5	8	15	15	15	10	8
12. Copper (ug/1)	1	-	2	1	1	2	2	6	1	1
13. Cyanide (mg/1)	.00	.00	.00	.00	.00	.00	.01	.00	.00	.00
14. Fluoride (mg/1)	1.1	1.3	1.1	1.3	1.3	.8	.7	.3	.7	.8
15. Iron (ug/1)	20	60	90	10	20	10	30	290	50	20
16. Kjeldahl Nitrogen (mg/1)	.61	.59	.86	.58	1.0	1.9	.67	1.9	4.0	.40
17. Lead (ug/1)	6	-	3	2	1	4	0	1	1	2
18. Lithium (ug/1)	20	-	10	20	20	20	20	10	10	10
19. Magnesium (mg/1)	46	56	48	49	47	49	45	34	39	50
20. Manganese (ug/1)	67	-	110	110	70	70	70	30	20	120
21. Mercury (ug/1)	.1	--	.2	.0	.8	.0	.0	.1	.1	.1
22. Nitrate (mg/1) as NO_3	1.4	1.2	.97	.44	1.2	2.4	2.2	3.7	2.6	.40
23. Nitrite (mg/1) as NO_2	.03	.03	.03	.00	.00	.03	.03	.00	.00	.00
24. Odor	0	-	0	0	0	0	0	0	0	0
25. Oil & Grease (mg/1)	6	10	6	3	3	-	1	1	1	3
26. Ortho-Phosphorus (mg/1) (total)	.04	.04	.10	.03	.04	.11	.06	.06	.06	.01
27. Potassium (mg/1)	2.6	2.6	4.9	3.3	3.6	2.9	5.8	3.0	2.8	3.2
28. Selenium (ug/1)	1	1	1	1	1	1	1	2	1	1
29. Silica (mg/1)	16	16	14	12	14	13	16	15	16	16
30. Sodium (mg/1)	130	130	120	120	120	120	110	75	98	140
31. Solids, Dissolved (mg/1)	736	761	678	683	699	702	695	502	604	754
32. Sulfate (mg/1)	170	170	140	160	160	190	170	110	140	180
33. Sulfide (mg/1)	.1	.0	.2	.2	.2	.3	.2	.5	.1	.1
34. Turbidity (JTU)	10	80	20	20	130	34	120	480	70	4
35. Zinc (ug/1)	20	-	10	20	20	50	10	10	0	10
36. pH	9.0	8.5	8.0	8.5	8.5	8.4	8.6	8.4	8.2	8.4

DATA TO BE OBTAINED QUARTERLY AT FOUR MAJOR STATIONS

1. Complete Element Scan	-	-	-	-	-					
2. Radioactivity										
a. Gross Alpha (pcl) U Nat. Suspended	-	-	2.1	-	-	-	-	-	7.8	-
Radium 226*										
b. Gross Beta Cs-137 & Sr90 Suspended	-	-	6.2			-	-	-	12.3	-
Thorium 230**										
Uranium**										
3. Total Organic Carbon (TOC) (mg/1)	-	-	8.4	-	-	-	-	-	12	-
If TOC> 10 mg/liter, then										
a. Nitrogen (Base Extraction)										
b. Organic Carbon, Dissolved										
c. Organic Carbon, Suspended										
d. Phenols										
e. Polycyclic Aromatics										
f. Sulfur (Acid Extraction)										
4. COD	-	-	35	-	-	-	-	-	30	-
5. Coliform, Fecal	-	-	28	-	-	-	-	-	-	-
6. Pesticides	-	-	-	-	-	-	-	-	-	-

* Required if Gross Alpha> 4 picocuries per liter (pcl)
** Required if Gross Beta >1000 picocuries per liter (pcl)
N Non-Instantaneous Discharge

TABLE II A-2

SURFACE WATER QUALITY
BASELINE DATA

BASELINE DATA TO BE COLLECTED SEMI-MONTHLY — STATION: U.S.G.S. No. 09306022 Stewart Gulch Ab West Fork Nr Rio Blanco Co.
February 1975 - June 1975

	2/3	2/19	3/6	3/20	4/2	4/14	5/7	5/22	6/4					
1. Ammonia (mg/1) (Nitrogen)	.06	.05	.03	.03	.01	.00	.01	.01	.00					
2. Arsenic (ug/1)	3	1	0	2	0	0	0	1	0					
3. Barium (ug/1)	<100	<100	<100	<100	<100	<100	0	0	0					
4. Bicarbonate (mg/1)	519	516	510	437	497	474	505	480	492					
5. Boron (ug/1)	70	80	80	80	90	80	80	80	80					
6. Cadmium (ug/1)	1	1	0	0	1	0	0	0	0					
7. Calcium (mg/1)	98	93	95	97	95	97	98	93	93					
8. Carbonate (mg/1)	0	0	0	38	0	0	9	0	0					
9. Chloride (mg/1)	7.0	8.1	7.2	7.0	7.0	7.4	7.3	6.6	6.7					
10. Chromium (ug/1)	0	0	0	20	0	0	0	0	0					
11. Color (PCU)	3	3	20	8	0	2	4	2	1					
12. Copper (ug/1)	8	3	2	1	3	0	1	0	2					
13. Cyanide (mg/1)	.01	.02	.00	.00	.00	.01	.01	.00	.00					
14. Fluoride (mg/1)	.4	.3	.3	.1	.3	.2	.2	.3	.2					
15. Iron (ug/1)	10	10	40	20	30	10	50	20	60					
16. Kjeldahl Nitrogen (mg/1)	.45	.65	.46	.80	.36	.39	.24	.53	3.5					
17. Lead (ug/1)	6	2	0	3	2	0	0	2	2					
18. Lithium (ug/1)	10	20	20	10	10	10	20	10	0					
19. Magnesium (mg/1)	78	76	81	86	74	75	72	80	79					
20. Manganese (ug/1)	40	30	30	30	10	20	20	20	0					
21. Mercury (ug/1)	.0	.0	.0	.0	.1	.0	.0	.2	1					
22. Nitrate (mg/1) as NO_3	8.4	7.9	7.9	8.0	8.0	7.5	7.5	6.6	6.6					
23. Nitrite (mg/1) as NO_2	.03	.03	.03	.00	.00	.03	.00	.00	.03					
24. Odor	0	0	0	0	0	0	0	0	0					
25. Oil & Grease (mg/1)	9	8	7	4	3	1	1	2	1					
26. Ortho-Phosphorus (mg/1) (total)	.18	.05	.06	.03	.02	.04	.02	.02	.02					
27. Potassium (mg/1)	1.6	1.5	1.7	1.6	2.4	1.5	1.8	1.5	1.4					
28. Selenium (ug/1)	1	1	1	1	1	1	0	0	1					
29. Silica (mg/1)	16	15	15	14	15	14	15	14	15					
30. Sodium (mg/1)	120	120	120	120	120	120	130	120	120					
31. Solids, Dissolved (mg/1)	956	957	950	958	937	917	950	939	965					
32. Sulfate (mg/1)	370	380	370	370	370	360	360	380	400					
33. Sulfide (mg/1)	.1	.0	.1	.1	.2	.1	.1	.3	.0					
34. Turbidity (JTU)	5	30	10	16	17	8	2	12	23					
35. Zinc (ug/1)	20	60	20	30	20	20	10	0	10					
36. pH	8.8	8.5	8.1	8.4	8.6	8.4	8.6	8.1	8.1					

DATA TO BE OBTAINED QUARTERLY
AT FOUR MAJOR STATIONS

1. Complete Element Scan														
2. Radioactivity														
a. Gross Alpha (pcl) Suspended U Nat.	-	-	1.7	-	-	-	-	-	51.2					
Radium 226*														
b. Gross Beta CS-137 & Sr	-	-	4.5	-	-	-	-	-	6.8					
Thorium 230**														
Uranium**														
3. Total Organic Carbon (TOC) (mg/1)	-	-	3.1	-	-	-	-	-	4.4					
If TOC > 10 mg/liter, then														
a. Nitrogen (Base Extraction)														
b. Organic Carbon, Dissolved														
c. Organic Carbon, Suspended														
d. Phenols														
e. Polycyclic Aromatics														
f. Sulfur (Acid Extraction)														
4. COD	-	-	10	-	-	-	-	-	15					
5. Coliform, Fecal	-	-	0	-	-	-	-	-	-					
6. Pesticides	-	-	-	-	-	-	-	-	-					

* Required if Gross Alpha > 4 picocuries per liter (pcl)
** Required if Gross Beta >1000 picocuries per liter (pcl)
N Non-Instantaneous Discharge

TABLE II A-3

SURFACE WATER QUALITY
BASELINE DATA

BASELINE DATA TO BE COLLECTED SEMI-MONTHLY

STATION: U.S.G.S. No. 09306025 West Fork Stewart Gulch Nr. Rio Blanco Co.
November 1974, May and June 1975

	11/6	11/20	5/9	5/20	6/4	6/19
1. Ammonia (mg/1) (Nitrogen)	-	-	.02	.00	.00	.02
2. Arsenic (ug/1)	1	2	.0	1	.0	1
3. Barium (ug/1)	<100	<100	0	0	0	0
4. Bicarbonate (mg/1)	488	757	525	505	541	499
5. Boron (ug/1)	90	130	110	150	80	100
6. Cadmium (ug/1)	1	1	1	0	0	0
7. Calcium (mg/1)	82	130	94	78	90	93
8. Carbonate (mg/1)	-	-	0	0	0	0
9. Chloride (mg/1)	9.4	12	11	9.9	8.4	11
10. Chromium (ug/1)	-	-	0	0	0	0
11. Color (PCU)	-	-	5	30	15	5
12. Copper (ug/1)	1	1	2	1	2	3
13. Cyanide (mg/1)	-	-	.00	.01	.00	.01
14. Fluoride (mg/1)	.2	.2	.2	.2	.2	.2
15. Iron (ug/1)	210	20	40	80	30	220
16. Kjeldahl Nitrogen (mg/1)	-	-	.36	.55	1.3	.47
17. Lead (ug/1)	3	11	1	0	1	2
18. Lithium (ug/1)	0	0	10	10	0	10
19. Magnesium (mg/1)	84	120	82	100	97	93
20. Manganese (ug/1)	0	10	0	20	0	10
21. Mercury (ug/1)	.0	.0	.0	.2	.1	.0
22. Nitrate (mg/1) as NO_3	-	-	.09	.22	.09	.44
23. Nitrite (mg/1) as NO_2	-	-	.00	.00	.00	.03
24. Odor	0	-	0	0	1	2
25. Oil & Grease (mg/1)	-	-	1	1	1	2
26. Ortho-Phosphorus (mg/1) as P	.02	.02	.01	.00	.00	.00
27. Potassium (mg/1)	3.1	3.7	3.4	3.8	2.3	2.1
28. Selenium (ug/1)	5	0	1	0	0	1
29. Silica (mg/1)	13	17	7.5	2.8	5.4	11
30. Sodium (mg/1)	130	200	150	160	150	150
31. Solids, Dissolved (mg/1)	943	1450	1020	1100	1100	1080
32. Sulfate (mg/1)	380	590	410	500	480	470
33. Sulfide (mg/1)	-	-	.1	.2	.2	.2
34. Turbidity (JTU)	-	-	1	14	11	15
35. Zinc (ug/1)	40	20	4	20	0	0
36. pH	8.2	-	8.9	-	8.3	8.6

DATA TO BE OBTAINED QUARTERLY AT FOUR MAJOR STATIONS

1. Complete Element Scan	-	-
2. Radioactivity		
a. Gross Alpha (pcl)		
Radium 226*		
b. Gross Beta		
Thorium 230**		
Uranium**		
3. Total Organic Carbon (TOC) (mg/1)		
If TOC> 10 mg/liter, then		
a. Nitrogen (Base Extraction)		
b. Organic Carbon, Dissolved		
c. Organic Carbon, Suspended		
d. Phenols		
e. Polycyclic Aromatics		
f. Sulfur (Acid Extraction)		
4. COD		
5. Coliform, Fecal		
6. Pesticides		

* Required if Gross Alpha> 4 picocuries per liter (pcl)
** Required if Gross Beta >1000 picocuries per liter (pcl)
N Non-Instantaneous Discharge

TABLE II A-4

SURFACE WATER QUALITY
BASELINE DATA

BASELINE DATA TO BE COLLECTED SEMI-MONTHLY

STATION: U.S.G.S. 09306058 Willow Creek Nr Rio Blanco, Co.
February - June 1975

	2/3	2/9	3/6	3/20	4/3	4/15	5/7	5/22	6/4					
1. Ammonia (mg/l) (Nitrogen)	.08	.03	.08	.02	.01	.02	.03	.03	-					
2. Arsenic (ug/l)	4	0	0	2	1	3	0	1	-					
3. Barium (ug/l)	100	100	100	<100	100	<100	0	0	-					
4. Bicarbonate (mg/l)	531	536	537	496	509	484	489	472	-					
5. Boron (ug/l)	110	130	100	100	110	120	120	100	-					
6. Cadmium (ug/l)	1	1	0	0	0	0	0	0	-					
7. Calcium (mg/l)	100	96	94	97	98	98	82	84	-					
8. Carbonate (mg/l)	0	0	0	0	0	0	0	0	-					
9. Chloride (mg/l)	12	11	9.9	11	9.7	12	12	12	-					
10. Chromium (ug/l)	0	10	0	10	0	0	0	0	-					
11. Color (PCU)	0	5	20	5	3	3	8	3	0					
12. Copper (ug/l)	4	4	1	1	1	0	1	0	-					
13. Cyanide (mg/l)	.00	.00	.00	.00	.00	.01	.01	.00	-					
14. Fluoride (mg/l)	.3	.4	.4	.6	.4	.3	.3	.4	-					
15. Iron (ug/l)	10	20	50	10	20	10	40	20	-					
16. Kjeldahl Nitrogen (mg/l)	1.0	1.1	1.2	.73	.99	.51	.56	.46	-					
17. Lead (ug/l)	2	2	2	3	1	0	0	1	-					
18. Lithium (ug/l)	0	10	10	10	10	10	10	10	-					
19. Magnesium (mg/l)	74	74	75	79	72	74	78	81	-					
20. Manganese (ug/l)	30	20	50	30	10	0	20	20	-					
21. Mercury (ug/l)	.2	.0	.0	.0	.0	.0	.0	.0	-					
22. Nitrate (mg/l) as NO_3	1.9	1.6	1.7	1.7	1.4	.93	1.4	1.4	-					
23. Nitrite (mg/l) as NO_2	.00	.00	.03	.00	.00	.03	.03	.00	-					
24. Odor	0	0	0	0	0	0	0	0	-					
25. Oil & Grease (mg/l)	5	7	4	3	5	2	3	3	-					
26. Ortho-Phosphorus (mg/l) Total	.00	.07	.10	.04	.03	.04	.02	.01	-					
27. Potassium (mg/l)	2.3	1.8	3.8	3.0	3.3	1.8	2.3	2.4	-					
28. Selenium (ug/l)	1	0	1	1	0	1	1	1	0					
29. Silica (mg/l)	17	15	14	14	15	14	14	12	-					
30. Sodium (mg/l)	120	110	110	110	110	110	120	120	-					
31. Solids, Dissolved (mg/l)	940	915	894	901	901	860	882	906	-					
32. Sulfate (mg/l)	350	340	320	340	340	310	330	360	-					
33. Sulfide (mg.l)	.1	.1	.3	.1	.0	.2	.1	.2	-					
34. Turbidity (JTU)	30	200	100	55	40	33	72	5	-					
35. Zinc (ug/l)	30	50	30	10	30	30	10	0	-					
36. pH	7.5	7.9	8.2	8.2	8.2	8.3	9.4	8.9	-					

DATA TO BE OBTAINED QUARTERLY
AT FOUR MAJOR STATIONS

1. Complete Element Scan														
2. Radioactivity														
a. Gross Alpha (pcl) as U Natural	-	-	26						< .4					
Radium 226*														
b. Gross Beta as CS-137 & Sr90	-	-	38				-	-	< .12					
Thorium 230**														
Uranium**														
3. Total Organic Carbon (TOC) (mg/l)	-	-	16											
If TOC> 10 mg/liter, then														
a. Nitrogen (Base Extraction)														
b. Organic Carbon, Dissolved														
c. Organic Carbon, Suspended														
d. Phenols														
e. Polycyclic Aromatics														
f. Sulfur (Acid Extraction)														
4. COD	-	-	38											
5. Coliform, Fecal	-	-	5				-	-	-					
6. Pesticides	-	-	✓											

* Required if Gross Alpha> 4 picocuries per liter (pcl)
** Required if Gross Beta >1000 picocuries per liter (pcl)
N Non-Instantaneous Discharge

TABLE II A-5

SURFACE WATER QUALITY
BASELINE DATA

BASELINE DATA TO BE COLLECTED SEMI-MONTHLY

STATION: U.S.G.S. 09306061 Piceance Creek Ab Hunter Creek Nr Rio Blanco, Co.
February - July 1975

	2/3	2/19	3/6	3/20	4/3	4/15	5/7	5/22	6/4	6/19	7/2
1. Ammonia (mg/1) (Nitrogen)	.04	.03	.09	.03	.04	.06	.03	.02	-	.01	.00
2. Arsenic (ug/1)	5	1	1	0	0	3	2	2	-	1	3
3. Barium (ug/1)	<100	<100	100	<100	<100	<100	0	0	-	0	0
4. Bicarbonate (mg/1)	591	571	554	475	576	473	552	460	-	620	605
5. Boron (ug/1)	150	160	170	160	150	150	180	140	-	220	170
6. Cadmium (ug/1)	1	1	0	0	0	0	6	0	-	0	0
7. Calcium (mg/1)	88	84	81	82	83	74	77	63	-	78	84
8. Carbonate (mg/1)	0	0	0	39	0	0	11	0	-	0	0
9. Chloride (mg/1)	13	14	13	14	14	16	14	11	-	14	14
10. Chromium (ug/1)	10	0	0	0	0	0	0	0	-	0	0
11. Color (PCU) (PCU)	-	5	30	8	3	15	7	15	-	9	10
12. Copper (ug/1)	5	10	2	2	1	0	8	0	-	2	1
13. Cyanide (mg/1)	.00	.03	.00	.00	.00	.00	.01	.00	-	.02	.00
14. Fluoride (mg/1)	.6	.7	.7	.9	.7	.6	.6	.5	-	.7	.6
15. Iron (ug/1)	30	20	60	30	10	10	70	30	-	30	10
16. Kjeldahl Nitrogen (mg/1)	.46	1.9	.99	.61	.79	3.8	.33	1.3	-	.47	.21
17. Lead (ug/1)	2	1	2	3	0	0	0	1	-	2	1
18. Lithium (ug/1)	10	20	20	20	10	20	10	10	-	0	0
19. Magnesium (mg/1)	67	70	64	70	64	50	61	46	-	63	67
20. Manganese (ug/1)	40	30	30	30	0	50	20	30	-	50	40
21. Mercury (ug/1)	.1	.0	.0	.0	.0	.0	.0	.1	-	.0	.0
22. Nitrate (mg/1) as NO_3	3.0	3.5	2.7	2.9	2.6	2.1	2.5	3.0	-	1.5	.35
23. Nitrite (mg/1) as NO_2	.03	.00	.03	.03	.00	.03	.03	.00	-	.03	.00
24. Odor	0	0	0	0	0	0	0	0	-	0	0
25. Oil & Grease (mg/1)	8	4	4	3	2	8	1	2	-	1	2
26. Ortho-Phosphorus (mg/1) (total)	--	.06	.10	.04	.04	.10	.07	.07	-	.02	.01
27. Potassium (mg/1)	2.7	2.6	4.8	3.9	5.0	3.0	3.8	3.5	-	3.9	3.6
28. Selenium (ug/1)	1	1	1	1	1	1	1	2	-	1	1
29. Silica (mg/1)	17	16	15	13	15	14	16	15	-	18	17
30. Sodium (mg/1)	140	140	130	130	140	120	130	100	-	160	170
31. Solids, Dissolved (mg/1)	944	923	835	851	889	734	839	639	-	906	985
32. Sulfate (mg/1)	320	310	250	260	280	220	250	170	-	260	330
33. Sulfide (mg/1)	.2	.0	.2	.1	.1	.2	.1	.1	-	.5	.1
34. Turbidity (JTU)	10	300	50	50	50	670	72	340	-	28	3
35. Zinc (ug/1)	30	40	10	20	20	30	20	10	-	0	10
36. pH	7.5	8.0	8.1	8.7	7.8	8.3	9.2	-	-	8.0	8.4

DATA TO BE OBTAINED QUARTERLY
AT FOUR MAJOR STATIONS

1. Complete Element Scan											
2. Radioactivity									-		
a. Gross Alpha (pcl) as U Natural	-	-	8.1	-	-				12		
Radium 226*											
b. Gross Beta as Cs-137 & Sr90	-	-	126	-	-	-	-	-	22	-	-
Thorium 230**											
Uranium**											
3. Total Organic Carbon (TOC)	-	-	8.2	-	-						
If TOC> 10 mg/liter, then											
a. Nitrogen (Base Extraction)											
b. Organic Carbon, Dissolved											
c. Organic Carbon, Suspended											
d. Phenols											
e. Polycyclic Aromatics											
f. Sulfur (Acid Extraction)											
4. COD	-	-	24	-	-						
5. Coliform, Fecal	-	-	12	-	-						
6. Pesticides	-	-	-	-	-						

* Required if Gross Alpha> 4 picocuries per liter (pcl)
** Required if Gross Beta >1000 picocuries per liter (pcl)
N Non-Instantaneous Discharge

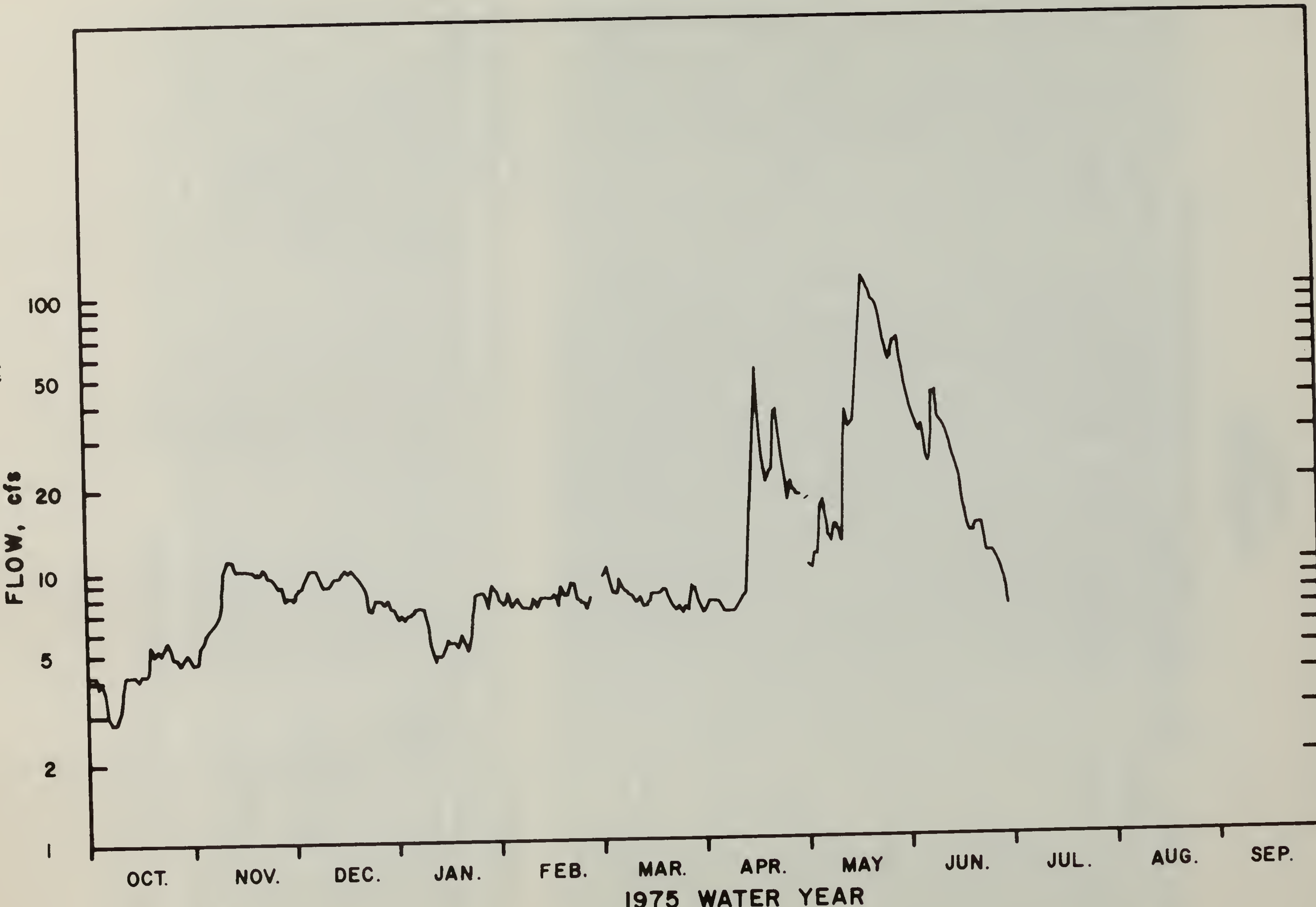


FIGURE II A-2 HYDROGRAPH-USGS # 09306007

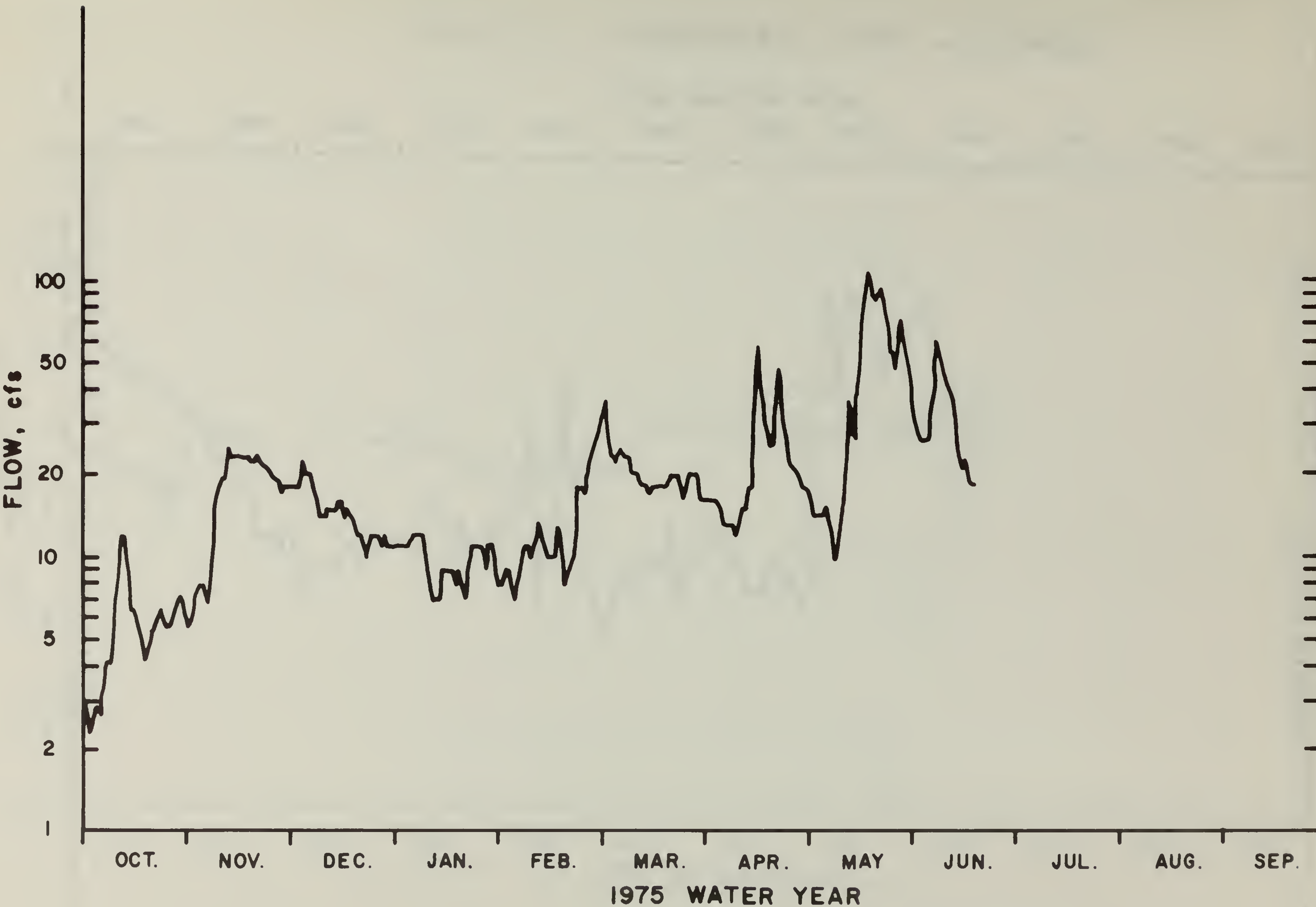


FIGURE II A-3 HYDROGRAPH USGS # 09306061

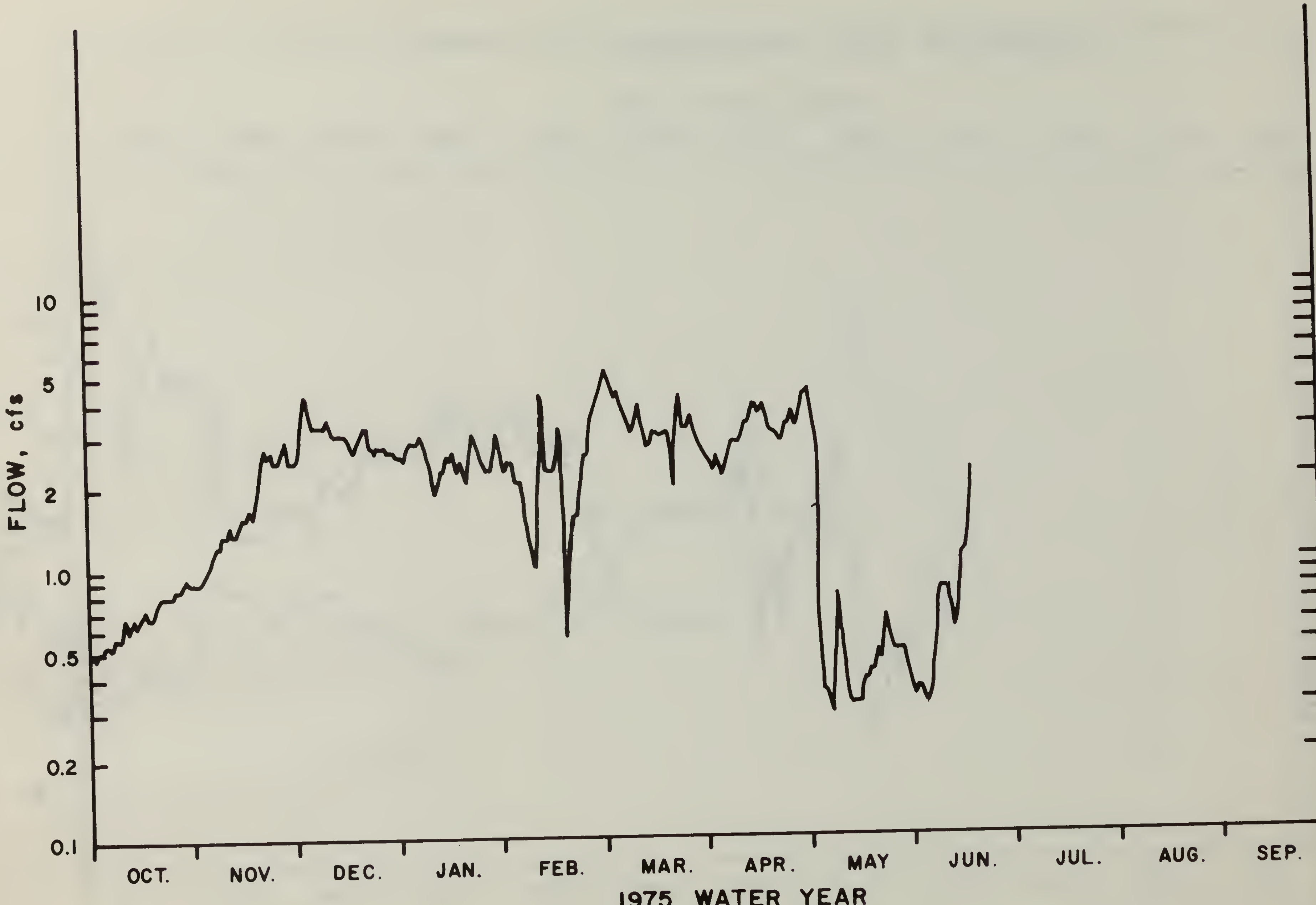


FIGURE II A-4 HYDROGRAPH USGS #09306058

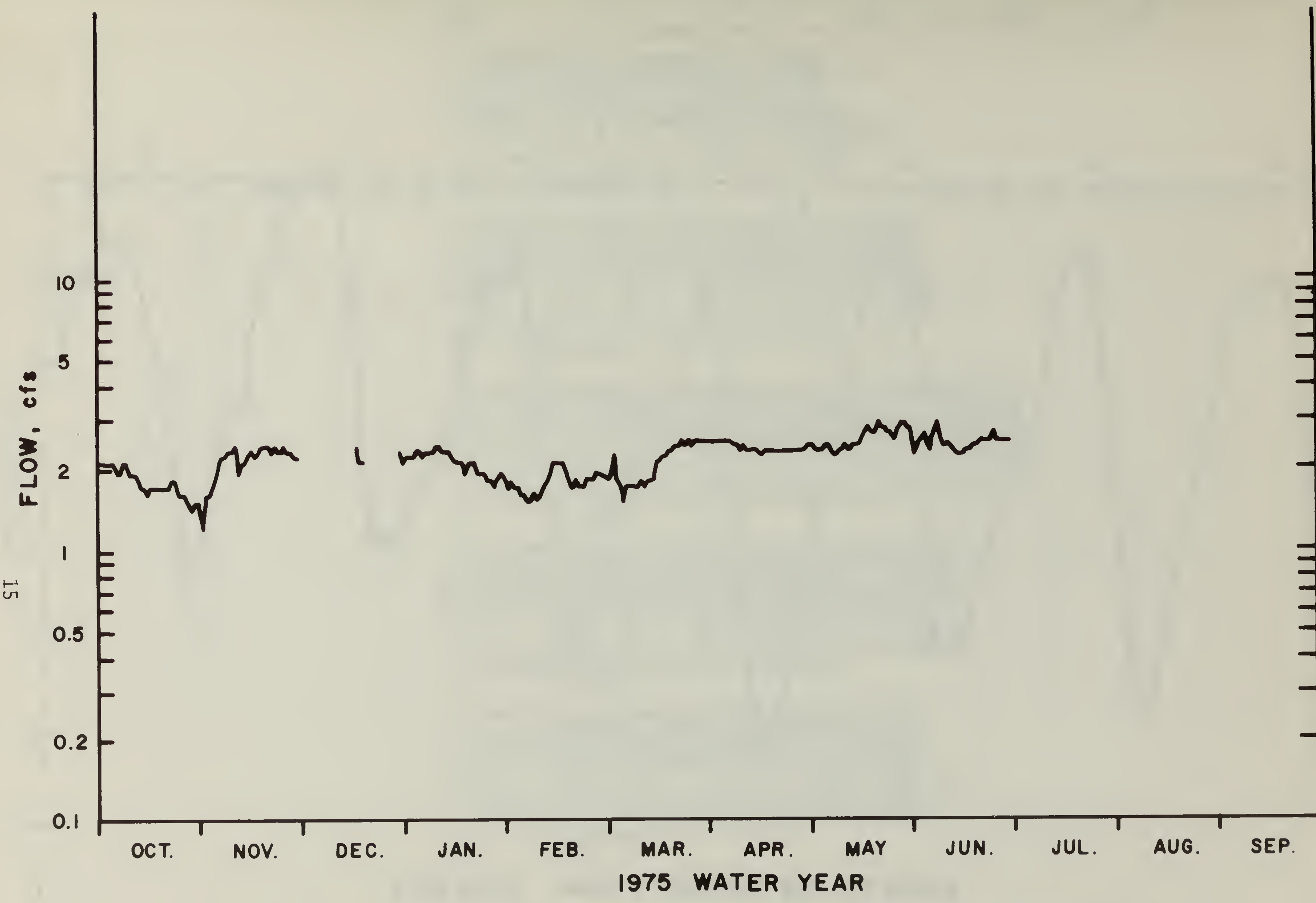
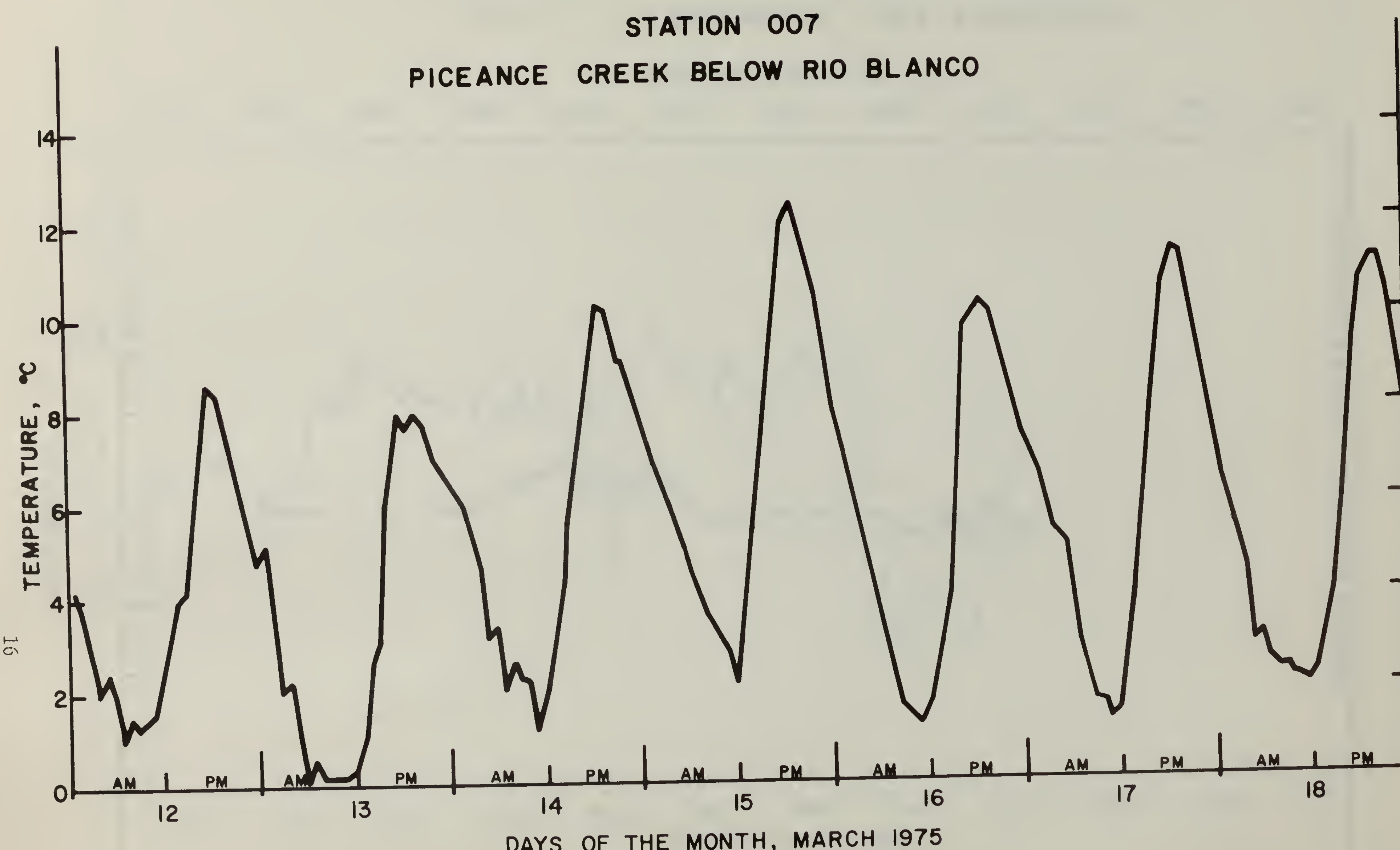


FIGURE II A-5 HYDROGRAPH USGS # 09306022



DIURNAL WATER TEMPERATURE VARIATIONS

FIGURE II A-6

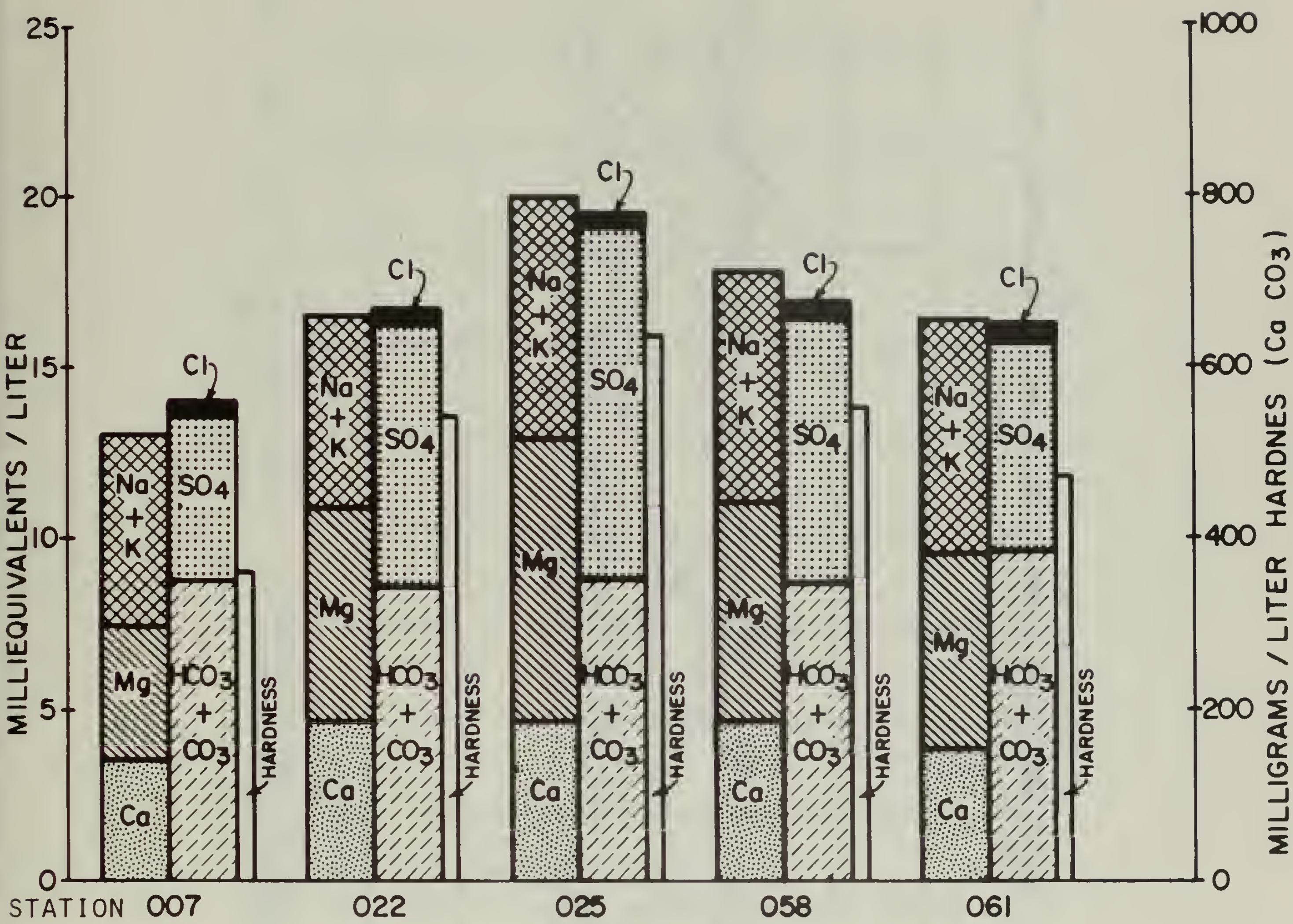


FIGURE II A-7 DISTRIBUTION OF MAJOR IONS
SURFACE WATER STATIONS, TRACT C-b
(12-month Average)

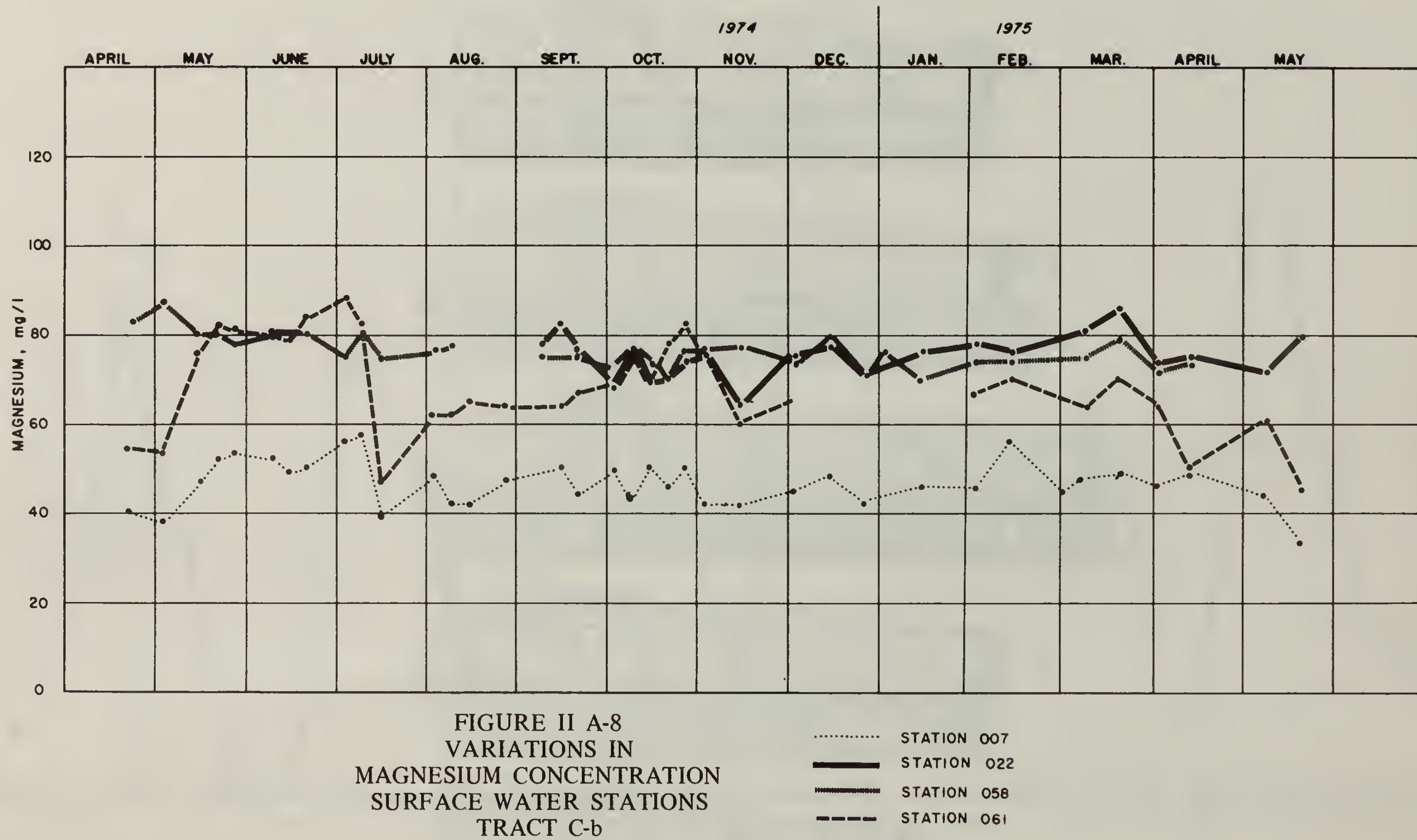


FIGURE II A-8
VARIATIONS IN
MAGNESIUM CONCENTRATION
SURFACE WATER STATIONS
TRACT C-b

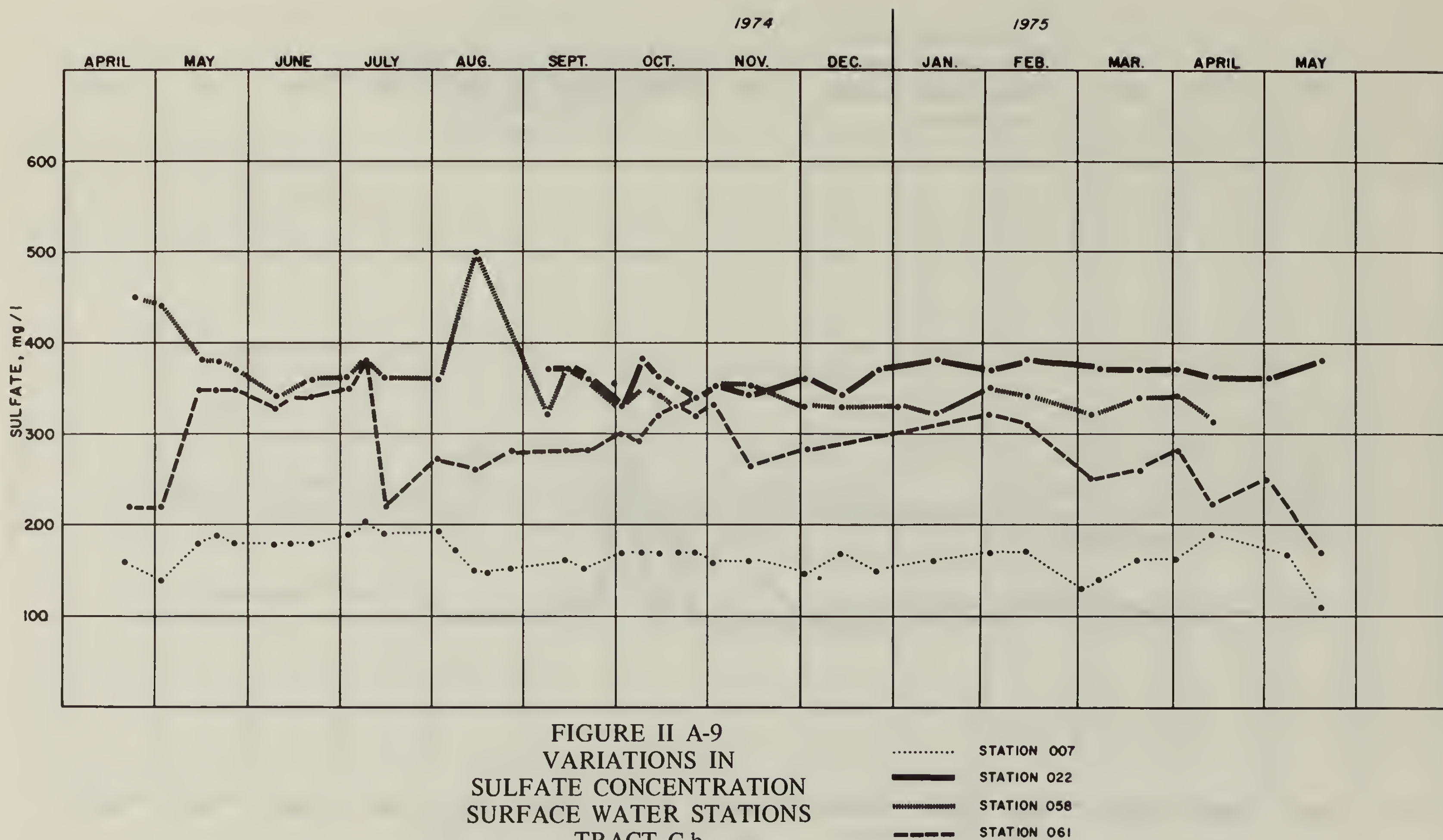


FIGURE II A-9
VARIATIONS IN
SULFATE CONCENTRATION
SURFACE WATER STATIONS
TRACT C-b

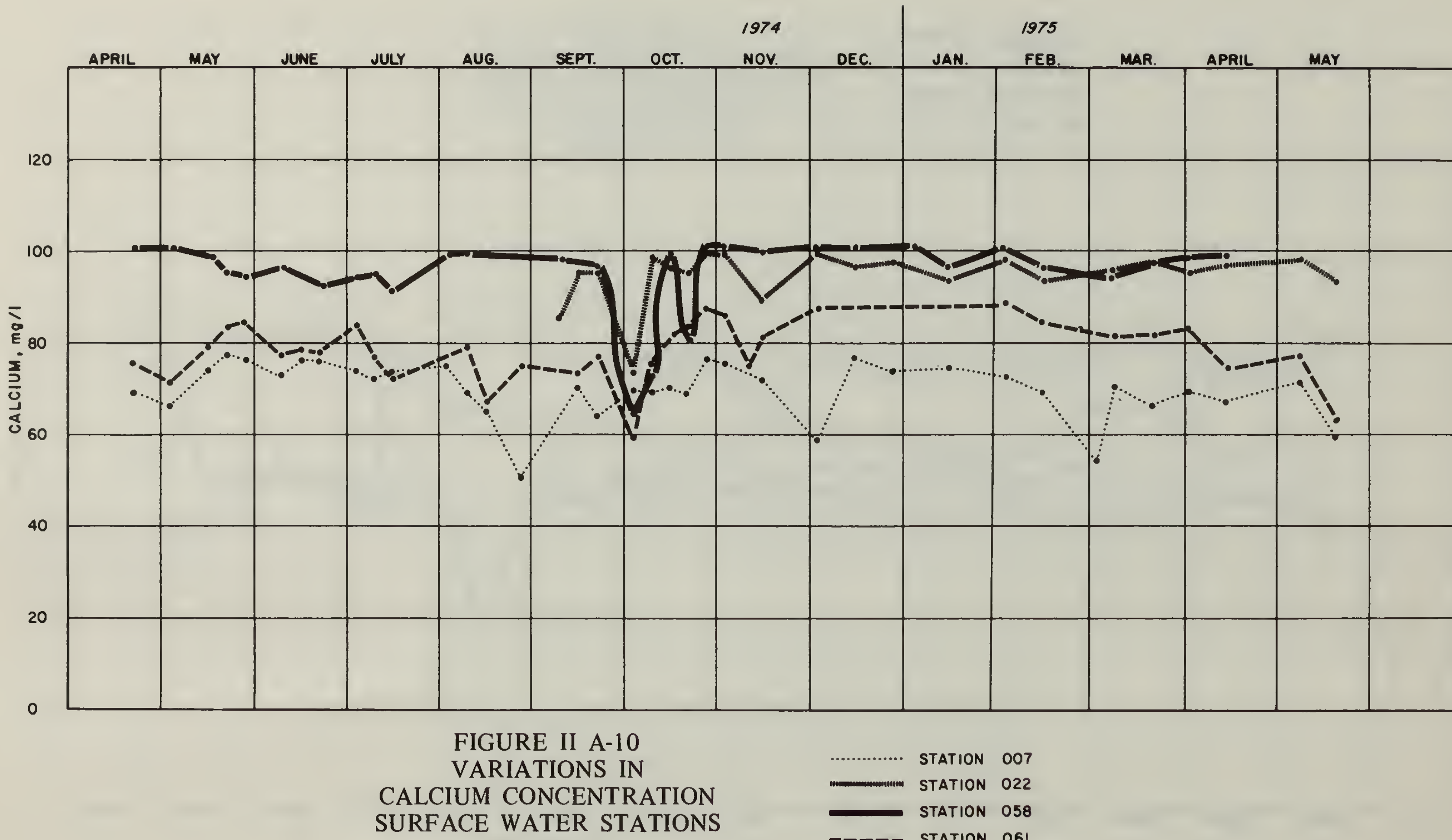


FIGURE II A-10
VARIATIONS IN
CALCIUM CONCENTRATION
SURFACE WATER STATIONS
TRACT C-b

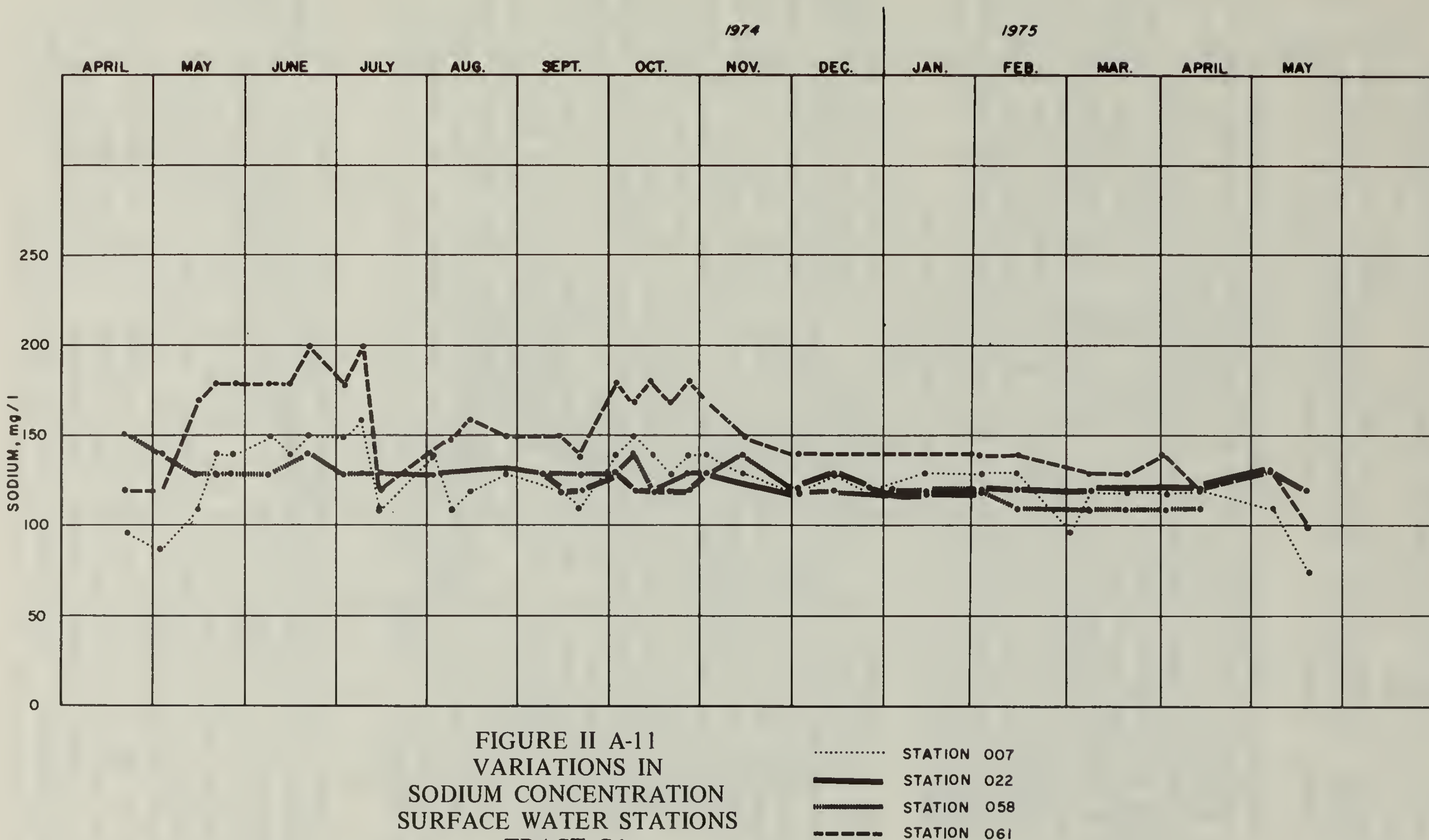


FIGURE II A-11
VARIATIONS IN
SODIUM CONCENTRATION
SURFACE WATER STATIONS
TRACT C-b

solids (TDS), the upstream station, 007, along Piceance Creek shows the lowest concentration as well as the lowest concentrations of most constituents. The median TDS at this location is 718 mg/l. Higher concentrations of TDS in the tributary streams, which reach a maximum of more than 1450 mg/l along Stewart Gulch, contribute to the downstream increase in TDS content of Piceance Creek. Below Tract C-b, the median TDS content is more than 900 mg/l.

To show the relationships between flow rate, or discharge, and TDS content, several chronological plots of ion concentration were made and compared to a plot of discharge (as determined manually at the time of sampling) over the same time period (Figures II A-12 and II A-13). Stations 007 and 061 on Piceance Creek show the same general pattern. For these two stations, from the second week in May, 1974, to the second week of July, 1974, the discharge on Piceance Creek was constantly low, with the discharge at the downstream station, 061, being lower than that at the upstream stations. This is the phenomenon of the growing season and withdrawal of water for irrigation. As a result, except for a few peak recordings, after mid-July the flows at Stations 007 and 061 are fairly equal until mid-November. From mid-November to mid-May the flow at the downstream station, 061, exceeds that at the upstream station, 007.

During the mid-May to mid-July low-flow period there is a general increase in concentrations of constituents. A similar increase is seen in October during which month the lowest flows have been recorded. This can be interpreted as a classic dilution effect--where the base stream flow originates from ground water sources with a high TDS. During periods of storm runoff or snow melt, the addition of higher quality runoff water results in a diluting effect and a lowering of concentrations of dissolved solids. The increase in TDS during the irrigation season can also be related to the irrigation process and leaching from the fields being irrigated. During these periods the concentrations of magnesium and sulfate appear to increase more at the downstream station, 061, then at the upstream station (Figures II A-8 and II A-9). There is no apparent explanation for the difference. Plots of calcium and sodium are given in Figures II A-10 and II A-11. From mid-November to mid-May the calcium-sodium ratio is greater at the downstream station than at the upstream station, but during the irrigation season the reverse is true (Figure II A-13). This change in concentration ratio may be attributed to ion exchange in soil and sediment--a common result of irrigation water percolating through the soil.

The dates of minimum and maximum concentrations for major constituents were examined. At Piceance Creek Stations 007 and 061, a preponderance of minimum values occurred on May 22, 1975. At this time, the discharge for that day is not known, but it is suspected of being relatively high. Precipitation records at Trailer 023 on May 21, 1975, show precipitation in the amount of 1.22 inches. The number and value of the minimum concentrations suggest appreciable dilution. At Station 007 minimums were recorded on May 22, 1975, for specific conductivity, bicarbonate, hardness, magnesium, sodium, chloride, fluoride, sulfate, and manganese. At Station 061 all the above elements except bicarbonate, fluoride, and manganese recorded minimums. In addition, calcium was recorded at its maximum value for the year on this same date. No other maximums were recorded, but

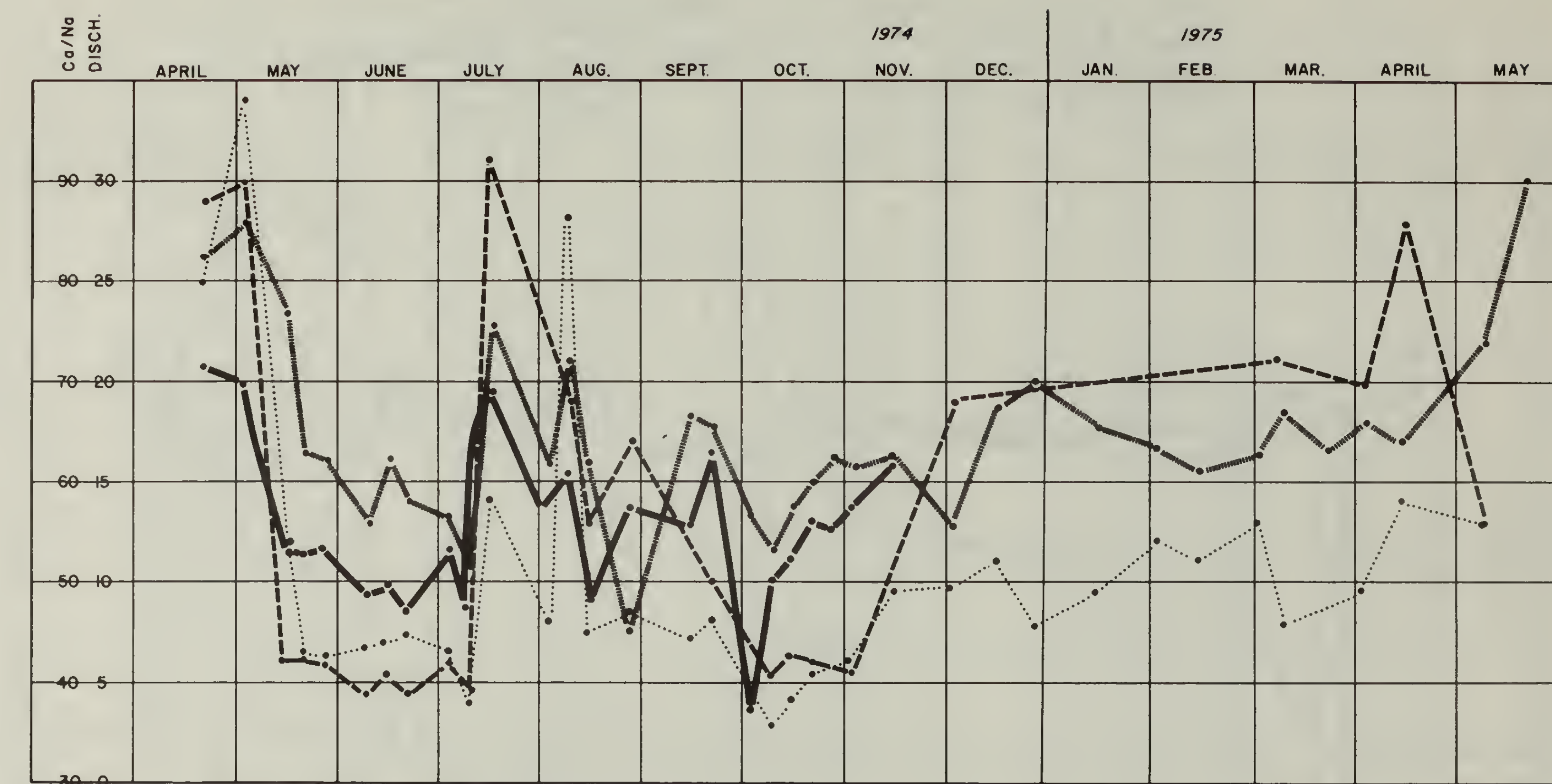


FIGURE II A-12
VARIATIONS IN
CALCIUM/SODIUM RATIO AND DISCHARGE
SURFACE WATER STATIONS
TRACT C-b

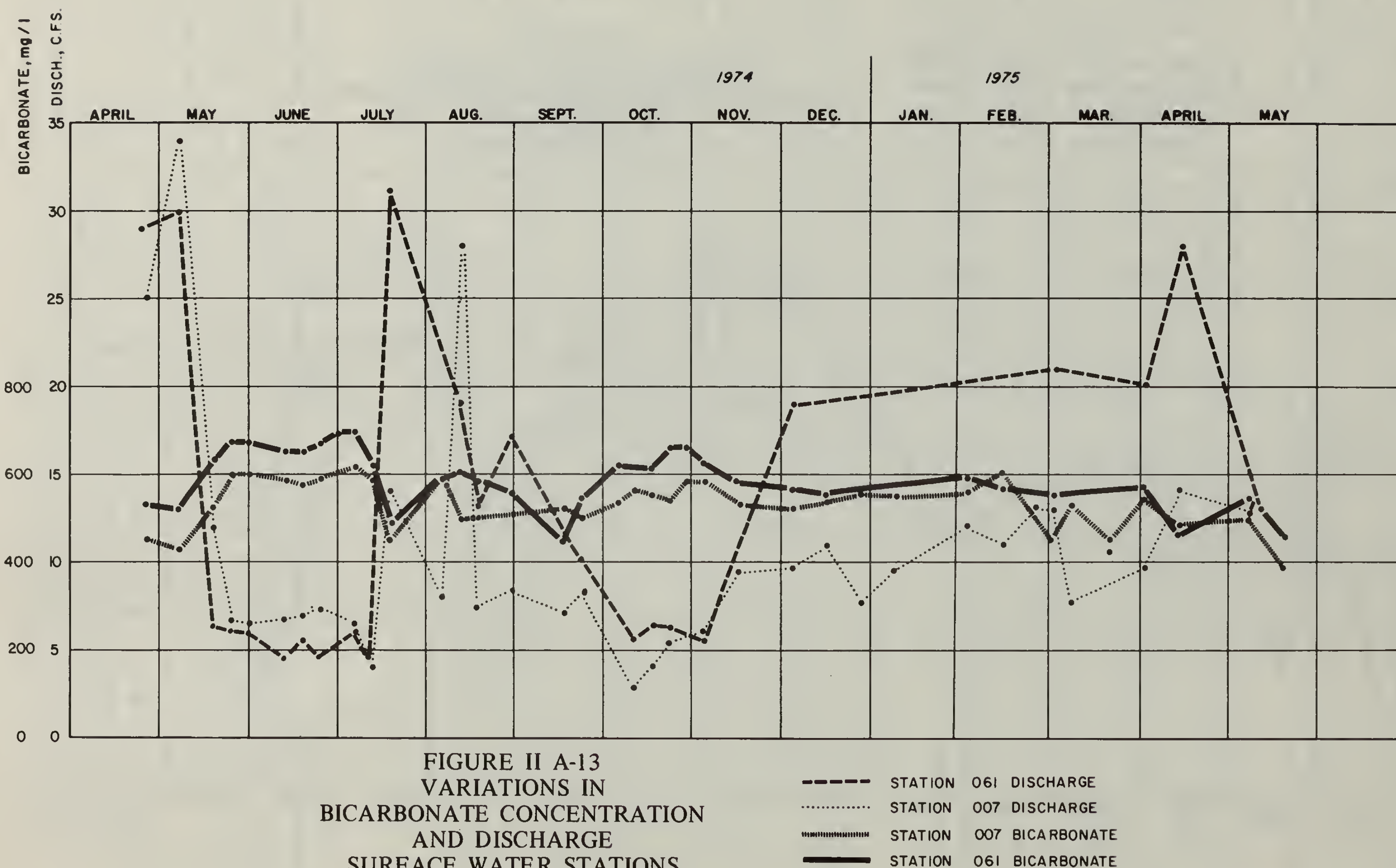


FIGURE II A-13
VARIATIONS IN
BICARBONATE CONCENTRATION
AND DISCHARGE
SURFACE WATER STATIONS
TRACT C-b

high readings for nitrite, nitrate, and iron were obtained. The low readings can be explained by dilution from storm runoff. An explanation for the high calcium reading at Station 007 is not apparent.

Maximum readings are more scattered, but on June 26, 1974, maximum readings were obtained at Station 007 for specific conductivity and at Station 061 for specific conductivity, potassium, chloride, sodium, and manganese. The lowest flow of the year was recorded on June 27, 1974 at Station 061; this date was near the end of the irrigation season.

On July 2 and 11, 1974, maximum values were recorded at both Piceance Creek stations for bicarbonate, hardness, magnesium, sodium, and sulfate. Maximums were also recorded for nitrate, nitrite, phosphate, and manganese at the upstream station. These maximum values occurred at the end of an eight-week period of constant low flow. It is not surprising that there was a concentration of the more soluble ions. The nitrite, nitrate, and phosphate maximums could be attributed to agricultural sources, e.g., fertilization of hay meadows with manure.

II A-2 Springs and Seeps

The Colorado State Division of Water Resources in a cooperative program with the U. S. Geological Survey has been collecting flow data from springs and seeps near the Tract. Some samples of spring flow were analyzed for water quality. Table II A-6 gives the locations of springs studied by the Division of Water Resources and their correspondence to those on Tract shown in Figure II A-14. Figures II A-15 and II A-16 are hydrographs of the flow recorded by Parshall flumes near four of these springs.

Table II A-7 presents water quality analysis for the springs inventoried near the Tract. This table was first presented in Summary Report #1. Analyses of spring water from spring S-10 reported in Quarterly Data Report #3 correspond with the analyses for S-10 reported in Table II A-7. The samples were collected about six months apart. It appears that the water quality from this spring is fairly constant. Water quality data for these springs sampled by the State are shown in Table II A-8.

The springs can be divided into two groups--those springs, S-1 to S-4, on Stewart Gulch and Piceance Creek, and those springs, S-6 to S-10, on Willow Creek. In general, a comparison of the reported water quality for these two groups indicates a difference in water chemistry. For example, the aluminum content reported at springs S-6, S-7, and S-10 is significantly higher than the aluminum content reported at other springs; the fluoride content is higher on Willow Creek, pH is slightly greater, and iron and nitrates are lower on Willow Creek than in those springs reported on Stewart Gulch (Table II A-9).

The high fluoride content of the Willow Creek samples suggests that the aluminum readings are correct since high fluoride concentrations increase the solubility of aluminum. In this case, however, explanations are necessary for the low aluminum in springs S-8 and S-9. At the present time, there are none.

Table II A-6

Locations of Springs and Seeps
Measured by Water Resources Divsion

Identification of Water Resources Division Springs			
Designation	I.D. #	Location	Corresponding Identification in Figure II A-14
S-1 and)*	1081	Lat 039° 49' 30"	S1 and S3
S-1-A)	1082	Lon 108° 11' 07"	
CER-6**	1063	Lat 039° 48' 25"	S2 and S4
		Lon 108° 10' 34"	
W-1	1078	Lat 039° 50' 20"	S6 and S7
		Lon 108° 14' 35"	
W-2	1110	Lat 039° 47' 36"	S9
		Lon 108° 14' 59"	
W-3	1079	Lat 039° 47' 17"	S10
		Lon 108° 15' 03"	

* These springs are adjacent to one-anther. Single flume measures the discharge from both the springs.

** This is a measuring site with flow coming from two upstream springs.

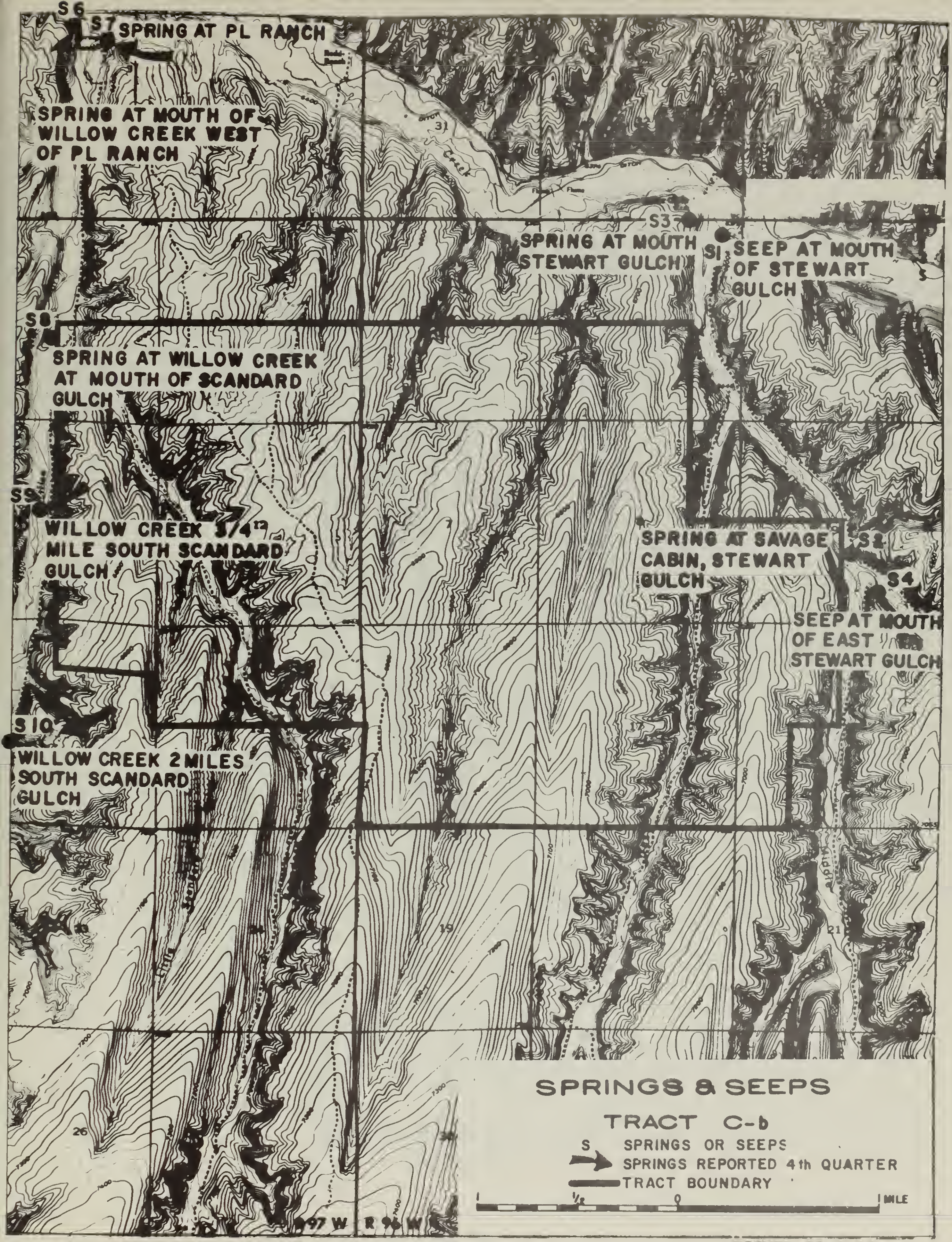


FIGURE II A-14

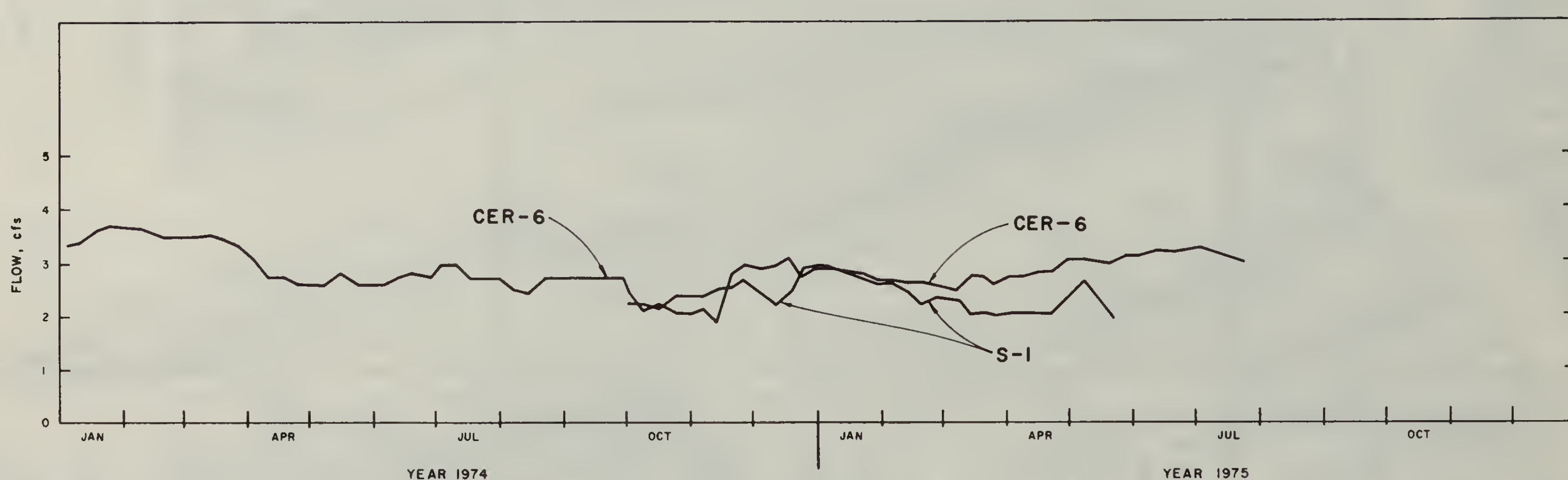


FIGURE II A-15 HYDROGRAPH – SPRINGS S-1 and CER-6

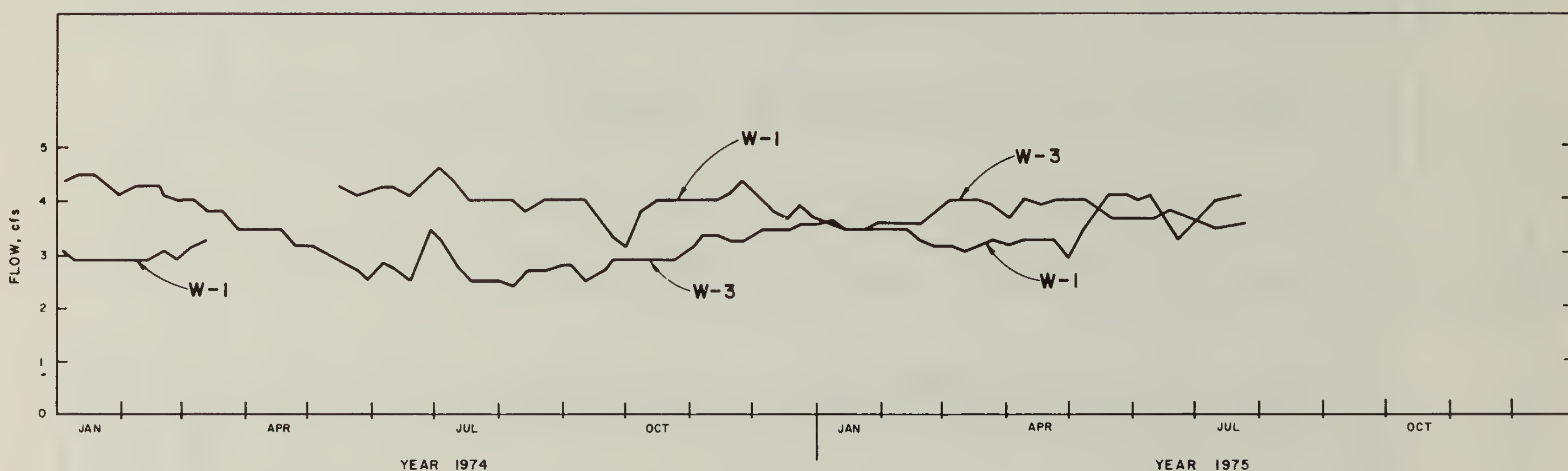


FIGURE II A-16 HYDROGRAPH – SPRINGS W-1 and W-3

TABLE II A-7

WATER QUALITY ANALYSIS

SEEPS and SPRINGS [(a)]

Location: (See Map) (unless stated otherwise, all units are mg/l)

	Element Measured	1	2	3	4	6	7	8	9	10
1.	Aluminum	.06	.1	.3	0.1	1.3	2.3	.2	.2	6.1
2.	Ammonia	.1	<.1	<.1	<.1	<.1	<.1	0.1	0.1	0.1
3.	Arsenic	.003	.004	.003		.03	.004		.002	.002
4.	Barium	.02	.05	.01	.05	.03	0.01	.06	.05	.05
5.	Beryllium	<.005	.002	<.006	.001	<.007	<.007	<.007	<.003	<.001
6.	Bicarbonate	520	495	520	480	560	520	606	516	540
7.	Bismuth	<.005	<.006	<.006	<.007	<.007	<.007	<.007	<.003	<.001
8.	Boron	1.4	1.2	1.1	1.2	1.6	1.6	0.2	0.4	0.6
9.	Cadmium	<.005	<.006	<.006	<.007	<.007	<.007	<.007	<.003	<.001
10.	Calcium	100	82	92	66	102	116	143	130	161
11.	Carbonate	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
12.	Cerium	<.005	<.006	<.006	.005	<.007	<.007	.005	.002	.002
13.	Chloride	4.2	4.8	4.8	3.5	4.	4.	4.0	4.0	0.8
14.	Chrome, Hexavalent	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
15.	Cobalt	0.002	<.006	.004	0.03	0.01	0.002	.02	.05	.002
16.	Conductivity, Specific	1380	1145	1250	1100	1250	1260	1280	1180	1180
17.	Copper	.04	.04	.03	.2	.05	.03	.2	.1	.03
18.	Fluoride	.9	.6	.7	.6	2.1	1.5	1.7	1.5	1.4
19.	Gallium	<.005	<.006	<.006	.006	0.005	0.006	<.007	<.003	<.001
20.	Hardness, Total	484	536	380	548	512	512	576	512	516
21.	Hydroxide	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
22.	Iron	1.8	.5	4.0	7.8	.8	.7	.14	.84	.47
23.	Lead	<.005	.01	.02	.04	.03	.03	<.007	<.003	.02
24.	Lithium	.05		.03	.3	.4	.1	.1	.5	.2
25.	Magnesium	57	81	37	93	63	54	53	46	28
26.	Manganese	.2	.02	.04	1.4	.03	.01	.1	.05	.06
27.	Mercury	.001	.001	.002	.001	.0017	.0003	.0001	.0001	.0014
28.	Molybdenum	<.005	<.006	<.006	.013	0.01	<.007	.06	.2	.02
29.	Nickel	0.02	.004	.01	.08	0.01	0.009	.01	.02	.005
30.	Nitrate	8.1	5.4	5.6	6.0	2.7	2.9	1.1	1.7	.1
31.	pH	7.9	8.0	7.6	7.8	8.2	8.1	7.9	8.1	7.9
32.	Phosphate, Total	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
33.	Potassium									
34.	Selenium	.005	<.006	<.006	<.007	<.007	<.007	<.007	<.003	<.001
35.	Silica	12	13	13	13	15	16	13	14	13
36.	Silver	<.005	<.006	<.006	<.007	<.007	<.007	<.007	<.003	<.001
37.	Sodium	200	110	195	90	163	147	138	152	125
38.	Solids, Dissolved	1078	875	972	805	988	967	995	948	910
39.	Strontium	1	3	2	4	5	2	3	1	1
40.	Sulfate	440	335	370	290	360	375	350	350	310
41.	Titanium	0.1	.06	.08	0.1	0.3	0.2	0.2	0.2	0.2
42.	Vanadium	0.004	.005	.002	.009	0.004	0.004	.003	.005	.002
43.	Yttrium	<.005	.002	<.006	.003	<.007	<.007	<.007	<.003	<.001
44.	Zinc	0.04	.1	.3	.1	0.4	.08	.05	.2	.2
45.	Zirconium	<.005	<.006	<.006	<.007	<.007	<.007	<.007	<.003	<.001
46.	Radioactivity									
	Gross Alpha (pcl)	2.8	2.1	3.4	4	3.3	1.6	4.2	4.7	1.3
	Radium 226*							0.3	0	
	Gross Beta (pcl)	0	0	0	0	0	0	0	0	0
	Thorium 230**									
	Uranium**									
47.	Total Organic Carbon (TOC)	6	3	4	3	3	6	3	3	6
	Dissolved Organic Carbon***									
	Suspended Organic Carbon***									
	Phenols***									
	Sulfate, Acid Extraction***									
	Nitrogen, Base Extraction***									

* To be reported if gross alpha is greater than 4 picocuries per liter (pcl).
** To be reported if gross beta is greater than 100 picocuries per liter (pcl).
*** To be reported if TOC is greater than 10 mg. per liter.

1. Seep @ Mouth Stewart Creek 2. East Stewart Gulch Stream from Seeps @ Mouth 3. Spring at Mouth of Stewart Gulch 4. Spring at Savage Cabin Stewart Gulch 5. Mapped in error 6. Spring @ Mouth of Willow Creek West of PL Ranch 7. Spring @ PL Ranch 8. Spring @ Willow Creek at Mouth of Scandard 9. Willow Creek 3/4 mile past Scandard 10. Willow Creek 2 miles past Scandard

(a) all samples taken during week of September 30, 1974

Table II A-8

Water Quality Analysis
Seeps and Springs

(Preliminary Data obtained from Water Resources Division, State of Colorado)

Element Measured	Units	Identification of Springs W-1	W-2	W-3
Alkali, Total (as $CaCO_3$)	mg/1	497	482	442
Aluminum	μg/1	0	0	20
Arsenic	μg/1	0	0	1
Barium	μg/1	0	0	0
Bicarbonate	mg/1	606	588	534
Boron	μg/1	140	320	100
Bromide	mg/1	0.1	0.0	1.1
Calcium	mg/1	96	100	100
Carbonate	mg/1	0	0	0
Chloride	mg/1	11	9.1	9.0
Fluroide	mg/1	0.6	0.5	0.4
Hardness (non-carbonate)	mg/1	98	98	120
Hardness (Total)	mg/1	590	580	560
Iron	μg/1	10	10	0
Lead	μg/1	1	1	1
Lithium	μg/1	0	0	0
Magnesium	mg/1	85	79	75
Manganese	μg/1	0	20	0
NO_2 + NO_3 as N	mg/1	0.84	0.28	0.55
pH		7.3	7.8	7.9
Phosphate, ortho as P	mg/1	0	0.01	0.04
Phosphate (ortho)	mg/1	0	0.03	0.12
Potassium	mg/1	2.3	1.3	1.3
Residue, calc. sum	mg/1	1020	976	906
Residue, (Dis)	Ton/AFT	1.96	0.66	1.79
SAR		2.5	2.4	2.0
Selinium	μg/1	1	0	0
Silicon	mg/1	21	20	18
Sodium	mg/1	140	130	110
Sodium	percent	34	33	30
Specific conductance	FLD	1400	1400	1300
Stream flow - instrument	cfs	0.71	0.25	0.73
Strontium	μg/1	4500	4400	3800
Sulfate	mg/1	360	340	320
Water, Temperature	°C	9	10.5	8.0
Zinc	μg/1	0	0	0
Total cations	mea/1	17.931	17.177	15.978
Total anions	mea/1	17.829	17.019	15.811

TABLE II A-9

MEAN AND STANDARD DEVIATION
FOR SELECTED ELEMENTS
FOUND IN SPRING WATER
TRACT C-b

	STEWART GULCH SPRINGS 1-4		WILLOW CREEK SPRINGS 6-10	
	Mean (mg/1)	Std. Dev.	Mean (mg/1)	Std. Dev.
Aluminum	0.14	0.052	2.02	0.964
			3.23	0.714 (springs 6, 7, & 10 only)
Fluoride	0.7	0.061	1.64	0.112
Iron	3.52	1.384	0.59	0.136
Nitrate	6.28	0.538	1.7	0.363
pH	7.82	0.075	8.04	0.056

Nitrogen in the form of dissolved nitrate is a major nutrient for vegetation, and found in biological wastes. The differences in nitrate content between Stewart Gulch and Willow Creek could be explained by any number of reasons, e.g., contamination of the spring pool with aniaml waste, decaying vegetation, or agricultural runoff contaminating the spring pool.

There are several hypotheses that can be made to explain the differences in water chemistry. Additional water samples will be collected. As these new data are analyzed the various hypotheses will be stated, tested, and reported in subsequent documents.

II B CORE DRILLING AND ASSOCIATED GROUND WATER

The initial vertical well drilling and coring program has been completed and most of the data generated has been previously published. Information contained herein that relates to this program deals with (1) data that, because of time constraints, were not included in previous reports, (2) additional analysis of aquifer test data, and (3) data obtained from water level measurements and the preliminary analysis of that data. Additional geologic and engineering information were also attained by a slant-hole coring program. The primary purpose of this slant-hole program was to acquire additional structural-fabric information for use in mine design.

Four slant holes were cored through the mine zone and then cemented back to the surface after reaching total depth. Cores from each slant hole were oriented and logged to obtain joint directions and inclination (strike and dip). This information will be used to help determine mine orientation, to evaluate pillar and roof design, and to aid in shaft design. Structural fabric may also be significant in hydrologic evaluations. Other information obtained from the slant-hole drilling program includes mechanical laboratory evaluation of cores for data to be used in foundation, shaft, and mine design, assay for additional data points for assessing the overall oil shale reserves, and gassy core tests and analysis.

Data from the completed slant-hole program and included in Quarterly Data Report #4 are well survey plats, completion reports, and gas sampling program information. All slant holes were drilled with fluid whereas the vertical wells were drilled with mist. Thus no drilling water quality information was obtained.

The Well Summary Table, II B-1, has been updated to reflect current data. Listed in the table are the various types of information which have been presented and the quarterly reports in which that information will be found. Figure II B-1 is an updated map of the Tract showing the well locations. To graphically summarize the core-drilling program, Tract C-b penetration charts are presented in Figure II B-2, sheets 1 and 2.

There has been a slight modification of format beginning with this report in that Water Quality and Aquifer Data subsections each have been regrouped to better present the dynamic nature of this program.

II B-1 Well Survey Plats

Survey plats for all vertical test wells, core holes and observation wells have been reported previously. The slant holes are designated NQ-4, NQ-7, NQ-12 and NQ-22. Well survey plats for NQ-7 and NQ-12 slant hole pad locations were included in Summary Report #3. Survey plats for NQ-4 and NQ-22 are included in Quarterly Data Report #4.

TABLE II B-1
WELL SUMMARY TABLE

	AT-1	AT-1a	AT-1a1	AT-1b	AT-1c	AT-1d	SG-1	SG1a	SG-6	SG-8	SG-9	SG-10	SG-10a	SG-11
1. Well Designation	AT-1	AT-1a	AT-1a1	AT-1b	AT-1c	AT-1d	SG-1	SG1a	SG-6	SG-8	SG-9	SG-10	SG-10a	SG-11
2. Well Type	AT	AT (CH)	AT	AT	AT	AT	CH	GHT	CH (AT)	CH	CH	CH (AT)	GHT	CH (AT)
3. Completion Date	1/23/75	7/1/74	7/10/74	7/20/74	8/18/74	7/28/74	12/6/74	2/7/75	8/22/74	11/27/74	10/23/74	6/29/74	7/10/74	9/8/74
4. Total Depth (Geolograph) (feet)	1700	1621	1341	1638	1640	1640	2525	1180	2220	2608	2750	2211	1333	2826
5. Water Data														
a. Drilling Water Production	C1Q 2Q	C1Q	C1Q	C1Q	C1Q	C1Q	C2Q	C2Q	C1Q	C1Q	C1Q	C1Q	C1Q	C1Q
b. Drilling Water Samples (# taken)	1	4	NA	NA	4	NA	7	NA	5	7	5	4	NA	25
c. Water Quality Analyses	C1Q 2Q	C1Q			C1Q		C2Q		C1Q	C2Q	C1Q	C1Q		C1Q
6. Aquifer Data														
a. Drill Stem Tests		C1Q			C1Q		C2Q C3Q			C3Q		C1Q		
b. Jetting Tests	C1Q	C1Q	C1Q	C1Q	C1Q	C1Q	C2Q	C3Q	C1Q		C1Q	C1Q	C1Q	C1Q
7. Geophysical Logs,														
a. Schlumberger (1) Borehole, Compensated Sonic	C1Q	*		C1Q	C3Q	C1Q	C2Q		C3Q	C2Q	C2Q	*		C1Q
(2) Laterolog	C1Q	*		C1Q	C3Q	C1Q	C2Q		C3Q	C2Q	C2Q	*		C1Q
(3) Formation Density	C1Q	*		C1Q		C1Q	C2Q	C2Q		C2Q	C2Q	*		
(4) Compensated Neutron Formation Density		*		C1Q	C3Q	C1Q			C3Q			*		
(5) Temperature	C1Q	C1Q		C1Q	C3Q	C1Q	C2Q		C3Q	C2Q	C2Q	C1Q		C1Q
(6) Cement Bond Log		*		C3Q	C3Q	C3Q	C3Q		C3Q		C3Q	*		C3Q
(7) Perforated Depth Control							C3Q				C3Q			
(8) Casing Collar Log and Perforating Record														
(9) Oriented Perforating Record and Casing Collar Log				C3Q	C3Q	C3Q	C3Q		C3Q		C3Q			C3Q
b. Geophysical Logs, Other														
(1) Welex, Micro-seismogram		C1Q										C1Q		
(2) McCullough, Temperature				C1Q										
8. Field Lithologic Log	C1Q	C3Q	C1Q	C1Q	C1Q	C1Q	C3Q	C2Q	C3Q	C3Q	C3Q	C3Q	C1Q	C3Q
9. Cored Interval (feet from surface)														
a. Top	NA	1270	NA	NA	NA	NA	550	NA	1195	580	1200	1200	NA	750
b. Bottom	NA	1519	NA	NA	NA	NA	2525	NA	2220	2608	2750	2211	NA	2810
10. Assay Data														
a. Fischer Assay	NA	C1Q	NA	NA	NA	NA	C3Q	NA	C3Q	C3Q	C2Q	C1Q	NA	C3Q
b. Soluble Sodium	NA	C1Q	NA	NA	NA	NA	C3Q	NA	C3Q	C3Q	C2Q	C1Q	NA	C3Q
c. Alumina	NA	C1Q	NA	NA	NA	NA	C3Q	NA	C3Q	C3Q	C2Q	C1Q	NA	C3Q
11. Trace Element Analysis			C2Q 3Q							C2Q 3Q	C2Q 3Q	C2Q 3Q		
12. Rock Mechanics Data		C1Q										C1Q		
13. Gas Data														
a. Drilling Log	NA	NA	NA	NA		NA	C1Q		C1Q	C1Q	C1Q		NA	C1Q
b. Bomb Samples (# taken)	NA	NA	NA	NA	2	NA	8		4	11	8		NA	6
c. Bomb Analyses	C3Q	NA	NA	NA	C2Q	NA	C1Q 2Q		C1Q	C1Q 2Q	C1Q			C3Q C1Q
14. Completion Data	C2Q	C1Q	C1Q	C1Q	C1Q	C1Q	C3Q	C2Q	C1Q	C2Q	C1Q	C1Q	C1Q	C1Q
15. Survey Plat	C1Q	C1Q	C1Q	C1Q	C1Q	C1Q	C1Q	C3Q	C1Q	C1Q	C1Q	C1Q	C1Q	C1Q

KEY: NA = Not Applicable
Inc. = Incomplete
C1Q = Complete, First Quarterly Report
C2Q = Complete, Second Quarterly Report
C3Q = Complete, Third Quarterly Report

AT = Aquifer Test
CH = Core Hole
GHT = Groundwater Test Hole

*Birdwell Company logs run on this well instead of Schlumberger. See Quarterly Report #1.
**Alluvial Pump Test.
Not applicable. Wells drilled prior to granting C-b Tract Lease.

TABLE II B-1 (continued)
WELL SUMMARY TABLE

	SG-17	SG-18	SG-18a	SG-19	SG-20	SG-21	Cb-1	Cb-2	Cb-2b	Cb-3	Cb-4	NQ7B	NQ12D	NQ 4	NQ22
1. Well Designation	SG-17	SG-18	SG-18a	SG-19	SG-20	SG-21	Cb-1	Cb-2	Cb-2b	Cb-3	Cb-4	NQ7B	NQ12D	NQ 4	NQ22
2. Well Type	CH	AB (GHT)	GHT	CH GHT	GHT	GHT	GHT	GHT	AB (GHT)	GHT	GHT	CH	CH	CH	CH
3. Completion Date	1/13/75	10/13/74	10/18/74	9/28/74	12/13/74	1/8/75	#	#	9/20/74	#	#				
4. Total Depth (Geolograph)	2460	1430	1330	980	987	1036	2104	1482	1220	2122	1470	1740	1670	1554	1841
5. Water Data							#	#		#	#	----	None	----	----
a. Drilling Water Production	C2Q	C1Q	C1Q	C1Q	C2Q	C2Q			C1Q						
b. Drilling Water Samples	31	3	1	4	5	5									
c. Water Quality Analyses	C2Q 3Q	C1Q	C1Q	C1Q	C2Q	C2Q									
6. Aquifer Data							#	#		#	#	-----	None	----	----
a. Drill Stem Tests	C2Q 3Q				C2Q 3Q	C2Q 3Q									
b. Jetting Tests	C2Q 3Q	C1Q	C1Q	C1Q	C2Q	C2Q									
7. Geophysical Logs,															
a. Schlumberger (1) Borehole, Compensated Sonic	C2Q	C1Q		C1Q	C2Q	C2Q						*		*	*
(2) Laterolog	C2Q	C1Q		C1Q		C2Q						*	*	*	*
(3) Formation Density	C2Q	C1Q		C1Q	C2Q	C2Q						*	*	*	*
(4) Compensated Neutron Formation Density												*	*	*	*
(5) Temperature	C2Q	C1Q		C1Q	C2Q	C2Q	C2Q	C2Q		C2Q	C2Q	*	*	*	*
(6) Cement Bond Log	C3Q						C3Q	C3Q			C3Q				
(7) Perforated Depth Control	C3Q						C3Q	C3Q							
(8) Casing Collar Log and Perforating Record							C3Q	C3Q			C3Q				
(9) Oriented Perforating Record and Casing Collar Log	C3Q														
b. Geophysical Logs, Other															
(1) Birdwell, Caliper log												*	*	*	*
(2) McCullough, Temperature															
8. Field Lithologic Log	C3Q	C3Q	C1Q	C3Q	C2Q	C2Q	#	#	C1Q	#	#				
9. Cored Interval							#	#		#	#				
a. Top	800	1380	NA	930					NA			70	70	70	70
b. Bottom	2460	1426	NA	980								TD	TD	TD	TD
10. Assay Data							#	#	NA	#	#				
a. Fischer Assay	C3Q	C3Q		C1Q	C3Q	C3Q									
b. Soluble Sodium	C3Q	C3Q		C3Q	C3Q	C3Q									
c. Alumina	C3Q	C3Q		C3Q	C3Q	C3Q									
11. Trace Element Analysis							#	#	NA	#	#				
12. Rock Mechanics Data							#	#	NA	#	#				
13. Gas Data							#	#		#	#				
a. Drilling Log	C2Q	C1Q	C1Q	C1Q	C2Q				C1Q						
b. Bomb Samples	31	1	1	4	5	4			1			5	4	4	4
c. Bomb Analyses	C1Q-C3Q	C1Q	C1Q	C1Q	C2Q	C2Q			C1Q			C4Q	C4Q	C4Q	C4Q
14. Completion Data	C2Q	C1Q	C1Q	C1Q	C2Q	C2Q	C1Q	C2Q	C1Q	C1Q	C1Q	C4Q	C4Q	C4Q	C4Q
15. Survey Plat	C1Q	C1Q	C1Q	C1Q	C1Q	C1Q	C1Q	C1Q	C1Q	C1Q	C1Q	C3Q	C3Q	C4Q	C4Q

KEY: NA = Not Applicable
Inc. = Incomplete
C1Q = Complete, First Quarterly Report
C2Q = Complete, Second Quarterly Report
C3Q = Complete, Third Quarterly Report

AT = Aquifer Test
CH = Core Hole
GHT = Groundwater Test Hole

*Birdwell Company logs run on this well instead of Schlumberger. Logs in Quarterly Report #4.
**Alluvial Pump Test.
Not applicable. Wells drilled prior to granting C-b Tract Lease.

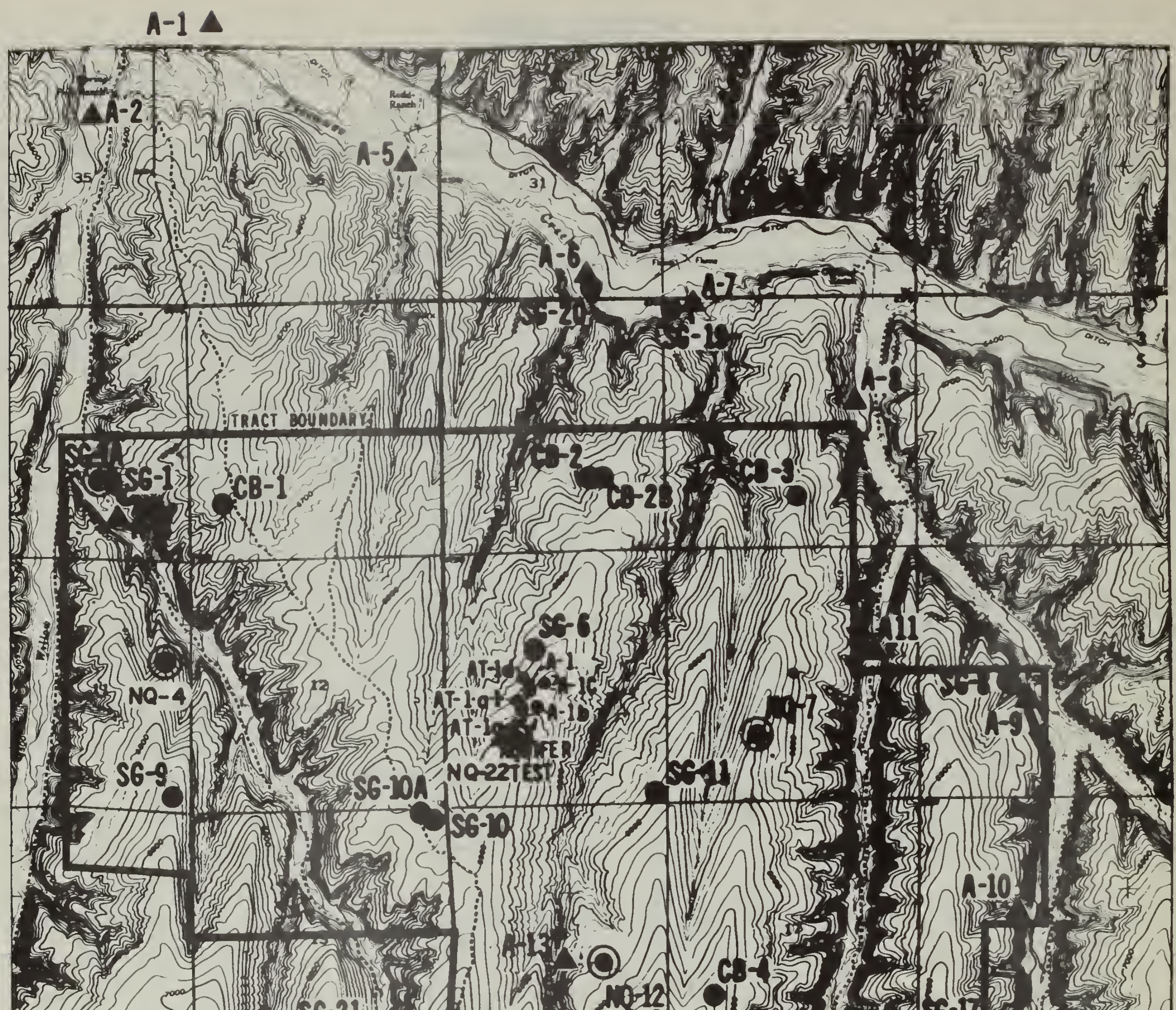
TABLE II B-1 (continued)
WELL SUMMARY TABLE

	A-1	A-2	A-3	A-4	A-5	A-6	A-7	A-8	A-9	A-10	A-11	A-12	A-13
1. Well Designation	A-1	A-2	A-3	A-4	A-5	A-6	A-7	A-8	A-9	A-10	A-11	A-12	A-13
2. Well Type	AW	AW	AW	AW	AW	AW	AW	AW	AW	AW	AW	AW	AW
3. Completion Date (1974)	10/2	10/4	10/7	10/8	10/3	10/10	9/28	10/1	9/23	9/23	9/24	9/24	10/8
4. Total Depth (Geolograph)	112	82	109	64	86	60	51	70	57	67	66	81	14
5. Water Data													
a. Drilling Water Production													
b. Drilling Water Samples													
c. Water Quality Analyses	C1Q	C1Q	C1Q	NA	C1Q	C1Q	C1Q	C1Q	C1Q	C1Q	C1Q	C1Q	NA
6. Aquifer Data													
a. Drill Stem Tests													
b. Jetting Tests													
7. Geophysical Logs,	NO LOGS RUN												
a. Schlumberger (1) Borehole, Compensated Sonic													
(2) Laterolog													
(3) Formation Density													
(4) Compensated Neutron Formation Density													
(5) Temperature													
(6) Cement Bond Log													
(7) Perforated Depth Control													
(8) Casing Collar Log and Perforating Record													
(9) Oriented Perforating Record and Casing Collar Log													
b. Geophysical Logs, Other													
(1) Welex, Micro-seismogram													
(2) McCullough, Temperature													
8. Field Lithologic Log	C1Q	C1Q	C1Q	C1Q	C1Q	C1Q	C2Q	C1Q	C1Q	C1Q	C1Q	C1Q	C1Q
9. Cored Interval	WELLS NOT CORED												
a. Top													
b. Bottom													
10. Assay Data	NO ASSAYS												
a. Fischer Assay													
b. Soluble Sodium													
c. Alumina													
11. Trace Element Analysis	NO ANALYSIS												
12. Rock Mechanics Data	NO ROCK MECHANICS DATA												
13. Gas Data	NO GAS DATA												
a. Drilling Log													
b. Bomb Samples													
c. Bomb Analyses													
14. Completion Data	C1Q	C1Q	C1Q	C1Q	C1Q	C1Q	C1Q	C1Q	C1Q	C1Q	C1Q	C1Q	C1Q
15. Survey Plat	C1Q	C1Q	C1Q	C1Q	C1Q	C1Q	C1Q	C1Q	C1Q	C1Q	C1Q	C1Q	C1Q

KEY: NA = Not Applicable
Inc. = Incomplete
C1Q = Complete, First Quarterly Report
C2Q = Complete, Second Quarterly Report
C3Q = Complete, Third Quarterly Report

AW = Alluvial Well

*Birdwell Company logs run on this well instead of Schlumberger. See Quarterly Report #1.
**Alluvial Pump Test.
Not applicable. Wells drilled prior to granting C-b Tract Lease.



A-1
A-2
A-5
A-6
A-7
SG-20
SG-19
A-8
TRACT BOUNDARY
SG-1A
SG-1
CB-1
CB-2
CB-2B
CB-3
SG-6
A-11
NQ-4
NQ-7
SG-9
SG-10A
SG-10
NQ-22TEST
SG-11
A-9
A-10
A-13
NQ-12
CB-4
A-12
SG-17
SG-21
TRACT BOUNDARY
SG-18A
SG-18
R 97 W
R 96 W
WELL LOCATIONS
TRACT C-b
ALLUVIAL WELLS
OTHER
1/2
0
1 MILE

FIGURE II B-1

FIGURE II B-2 SHEET 1

C-b TRACT DRILLING SUMMARY

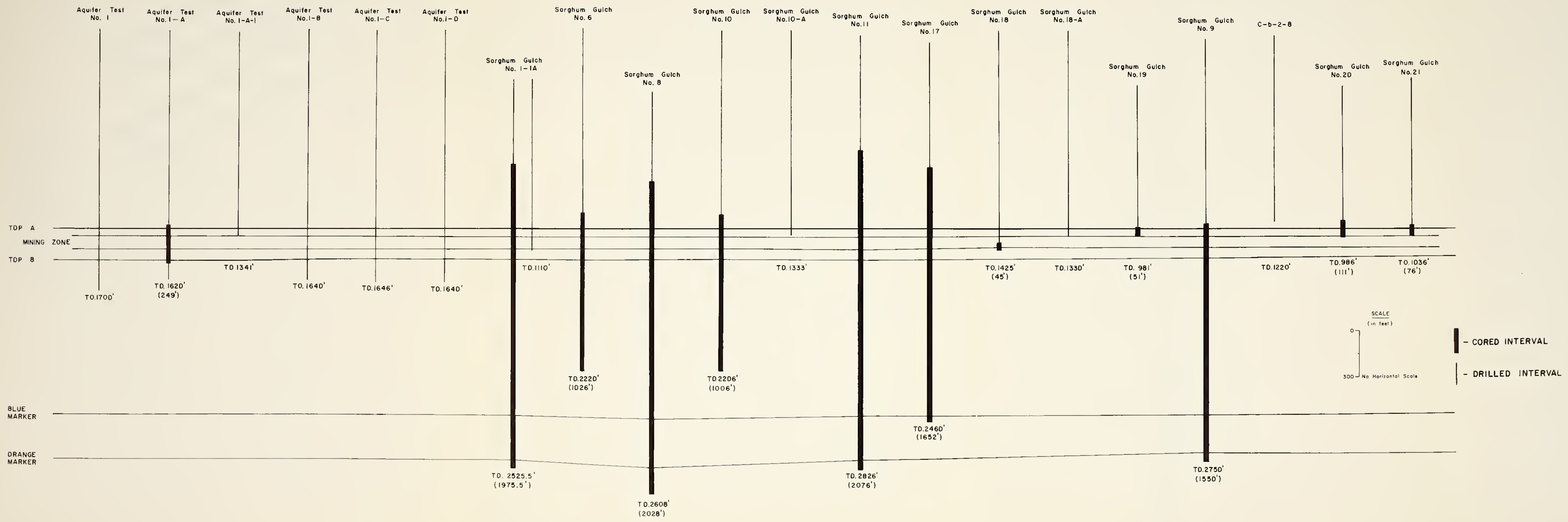
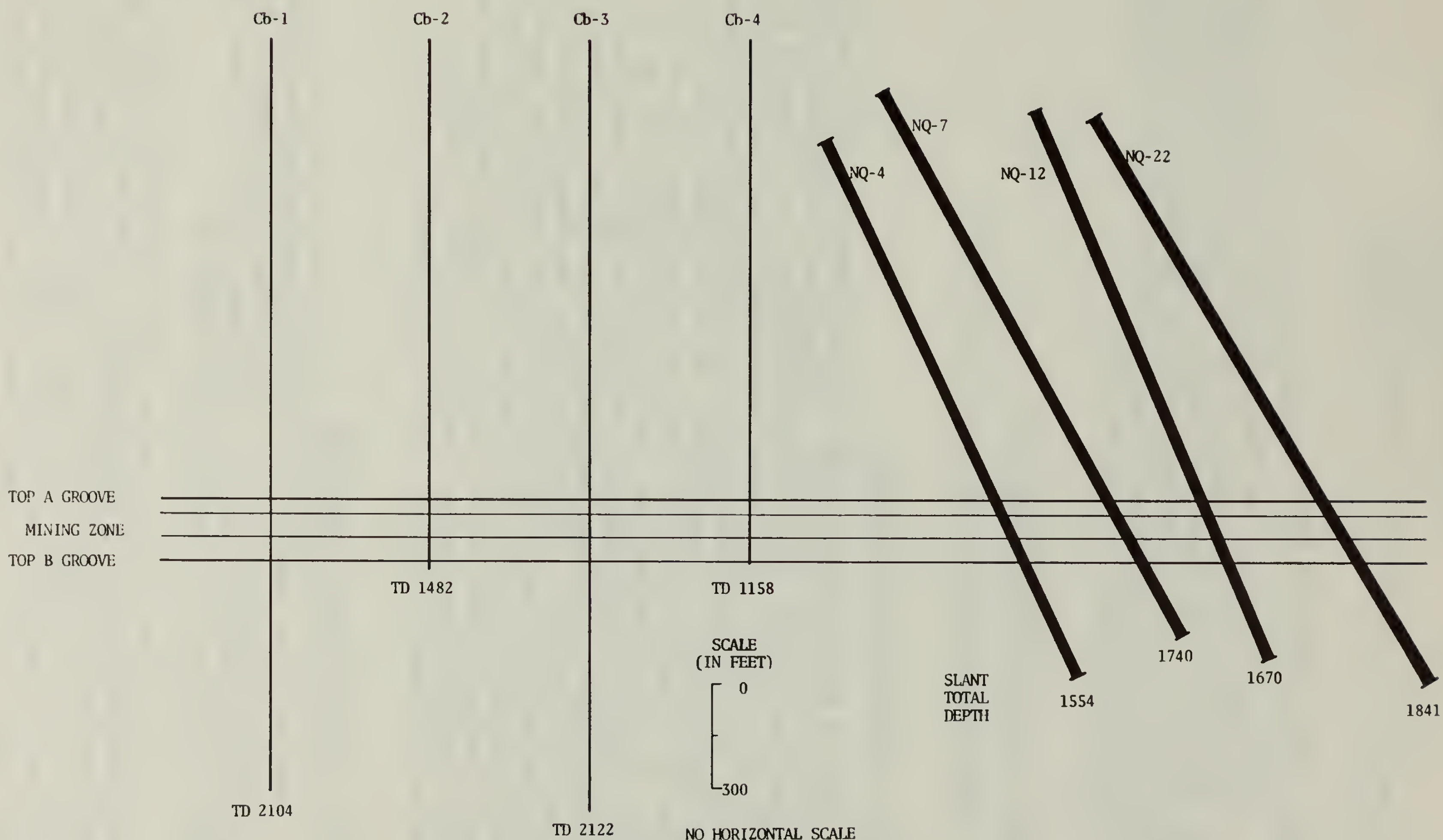


FIGURE II B-2 SHEET 2

TRACT C-b DRILLING SUMMARY



These new locations are shown on Figure II B-1.

II B-2 Well Completion Data

Well completion plats for the slant-holes are included in Quarterly Data Report #4. NQ-7A was abandoned at 800' with a reamer lodged in the hole. NQ-7B is a twin location to NQ-7A. The NQ-12 series holes are located just a few feet from each other on the NQ-12 pad. NQ-12A was abandoned because of a crooked hole. NQ-12B and NQ-12C were abandoned with drilling equipment left in the hole.

II B-3 Drilling Water Production

There are no data to report for this section.

II B-4 Water Quality - General

Data in this section include drilling water analysis, not previously reported for SG-11 and SG-17. Information on total dissolved solids obtained from jetting tests and drillstem tests are presented on Figures II B-3 and II B-4. Water from a jetting test is a composite of all water entering the well bore while water from a drillstem test is from a discrete depth interval. Nevertheless, these two figures show a wide variation in the water chemistry above the mining zone on Tract C-b. Also, within the Four Senators Zone, the total dissolved solids in SG-11 is fairly constant at approximately 600 mg/l; at SG-17, less than 1.5 miles to the southeast, the dissolved solids content increases abruptly from 500 mg/l to 1000 mg/l. On the other hand, the reverse exists between these two wells for water quality in the zone between the top of Parachute Creek and the top of Four Senators Zone. In this interval, the total dissolved solids content in SG-17 is significantly less and more stable throughout the section than it is at SG-11. Additional information can be found in section II B-5 of this report.

II B-5 Water Quality - Baseline

Baseline water samples were not collected during the fourth quarter. Baseline sampling occurs on a semi-annual basis and will be collected during the fifth quarter. Laboratory analysis of these samples should be available for Quarterly Data Report #5.

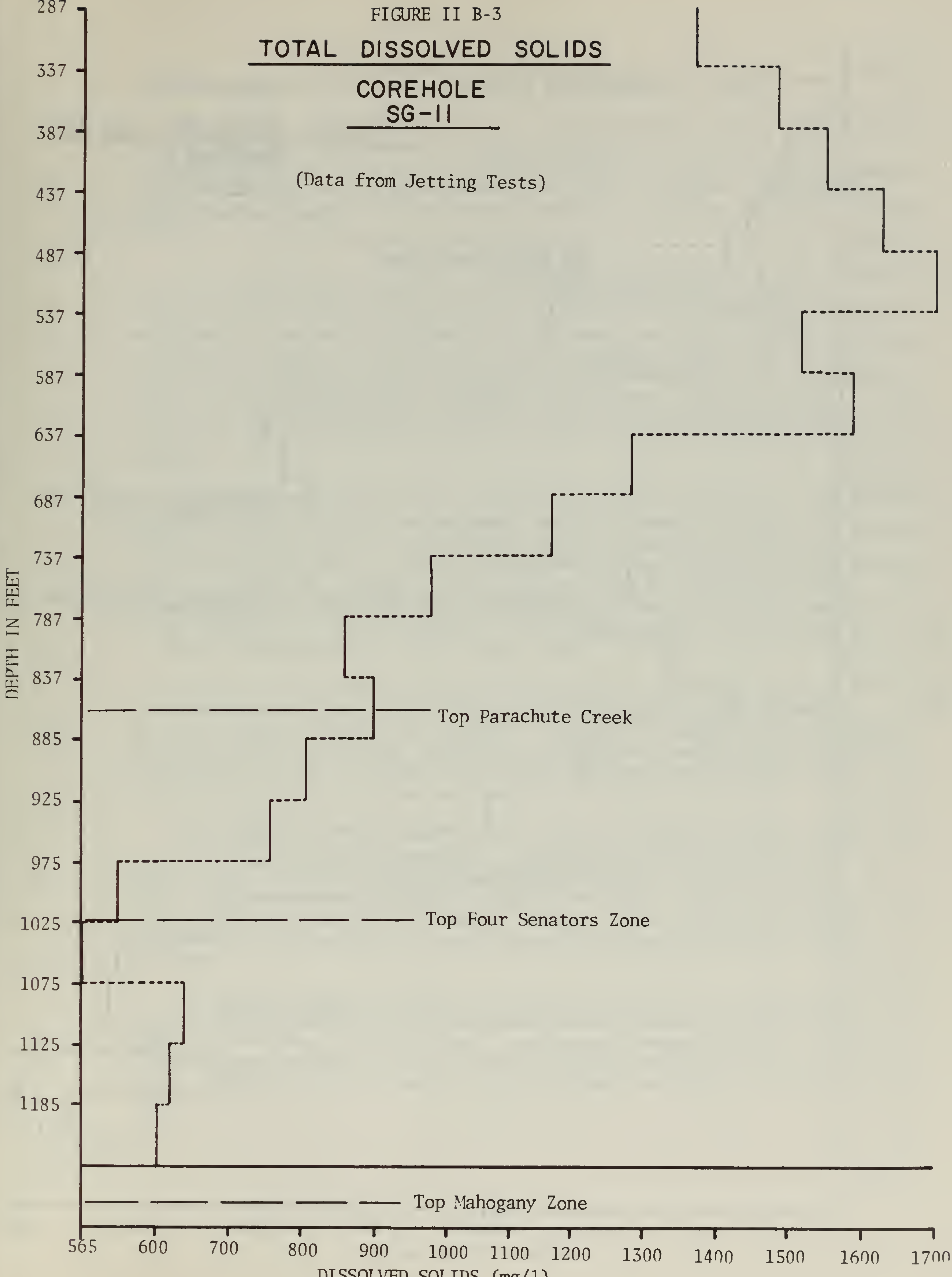
Stiff diagrams, plots of major anions and cations, were first presented and described in Summary Report #3. Diagrams for five wells were presented in Summary Report #3; this report presents Stiff diagrams for 16 water samples. For those samples where previous baseline data were not available for comparison, Stiff diagrams were made from water quality analysis on samples taken during jetting tests or from

FIGURE II B-3

TOTAL DISSOLVED SOLIDS

COREHOLE SG-11

(Data from Jetting Tests)



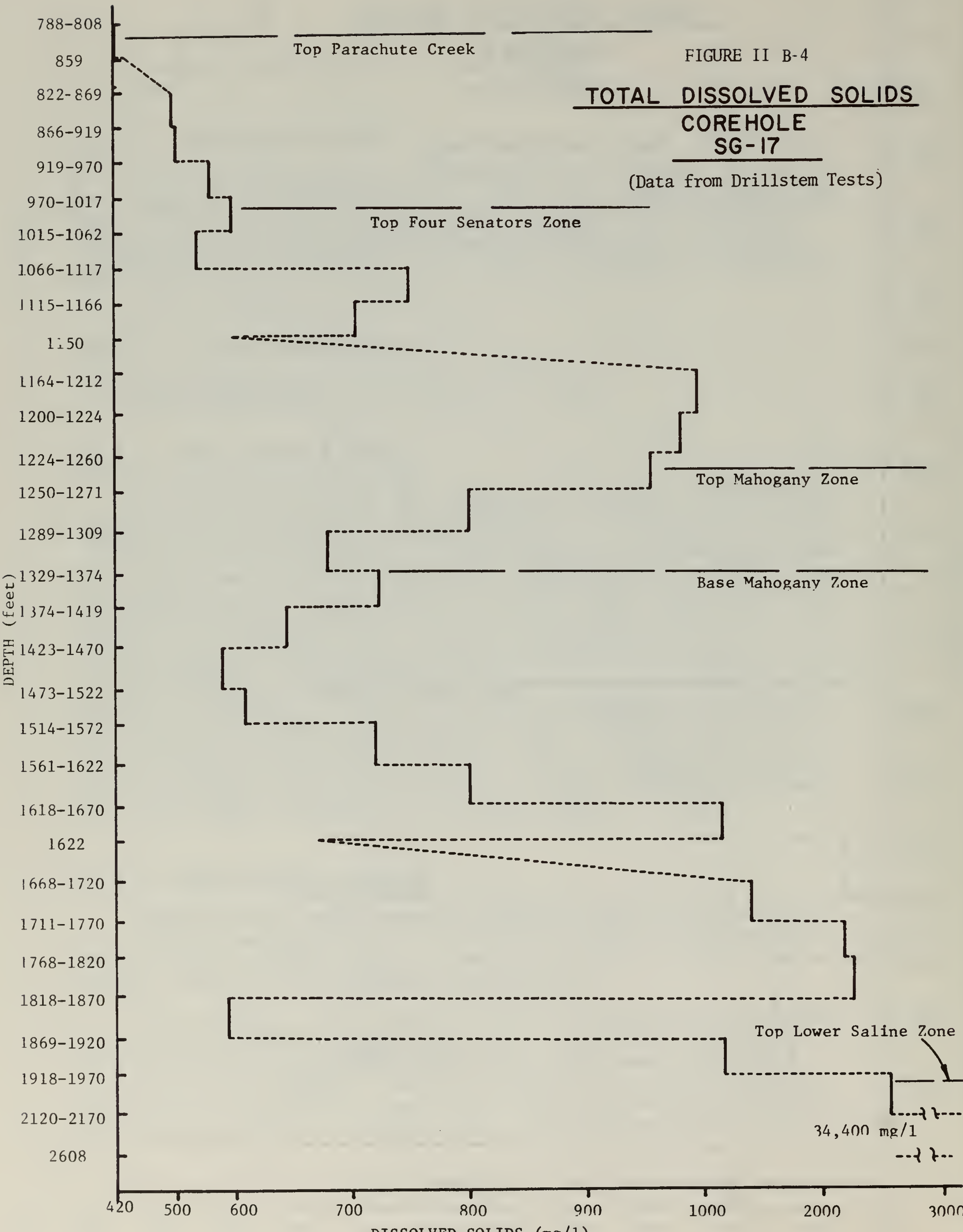


FIGURE II B-4
TOTAL DISSOLVED SOLIDS
COREHOLE
SG-17
(Data from Drillstem Tests)
Top Parachute Creek
Top Four Senators Zone
Top Mahogany Zone
Base Mahogany Zone
Top Lower Saline Zone
34,400 mg/1
DEPTH (feet)
788-808
859
822-869
866-919
919-970
970-1017
1015-1062
1066-1117
1115-1166
1150
1164-1212
1200-1224
1224-1260
1250-1271
1289-1309
1329-1374
1374-1419
1423-1470
1473-1522
1514-1572
1561-1622
1618-1670
1622
1668-1720
1711-1770
1768-1820
1818-1870
1869-1920
1918-1970
2120-2170
2608
420
500
600
700
800
900
1000
2000
3000
DISSOLVED SOLIDS (mg/1)

drilling water samples. (See Figure II B-5, sheets 1, 2 and 3.)

In general, the analyses of April's environmental samples from Cb-1, Cb-2, and Cb-4, (presented in Summary Report #3) A-9, A-10, SG-1, String #2, SG-9, SG-11, String #2, SG-20, and SG-21 exhibit the same form and hence similar ionic concentration, as previous samples. Apparently, these waters have undergone no change during the past four or five months.

The alluvial wells A-1, A-2, (in Summary Report #3), A-5, A-8, A-11 and A-21 show slightly differing Stiff diagram forms which reflect slightly different water analysis. Wells A-11 and A-12 principally show an increase in magnesium content while all the other wells exhibit a noticeable decrease in sodium. The original samples were taken by bailing the hole immediately after drilling. There could have been contamination by the drilling fluid. The April samples were collected after pumping at least 120 gallons of water; thus, these latest samples probably are more representative of the true water quality of the alluvial aquifer.

Wells SG-9 and SG-18a were sampled during their drilling in 1974 and again in April 1975. The original analysis showed basically a sodium bicarbonate water for SG-18a, typical of Parachute Creek waters. The 1975 analyses show a continuation of the sodium bicarbonate character at SG-18a and the upper aquifer water at SG-9 shows an increase in magnesium. The drilling water samples were composites of all water in the borehole at time of sampling. The latest samples are probably the most representative of their water types.

At well AT-1C water samples from all three strings are slightly different than in 1974, e.g., String #1 shows a decrease in carbonate, String #2 shows a decrease in sulfate. This well is about 100 feet from the pumped well, AT-1, used during the two aquifer drawdown tests. The flushing action of the pumped well should make the latest samples more representative of the various waters.

Other analysis can be made and the observed changes in water quality may take on additional meaning. As shown in Figure II B-6, in the upper aquifer areas of high concentrations of total dissolved solids (TDS) occur on the east-southeast edge of the Tract, just north of the Tract, and in the southwest corner of the Tract. A trough of lower concentrations of TDS appears to run diagonally southwest-northeast across the Tract.

In Summary Report #1, based on preliminary data, it was mentioned that, in general, conductivities increased to the northeast across the Tract. Since there exists a direct relationship between conductivities and TDS, based on Figure II B-6, that preliminary statement can be modified. Conductivities increase to the northeast and east across the Tract.

FIGURE II B-5
(SHEET 1.)

COMPARISON OF STIFF DIAGRAMS OF SELECTED WELLS

ANALYSIS AT SIX-MONTH INTERVALS

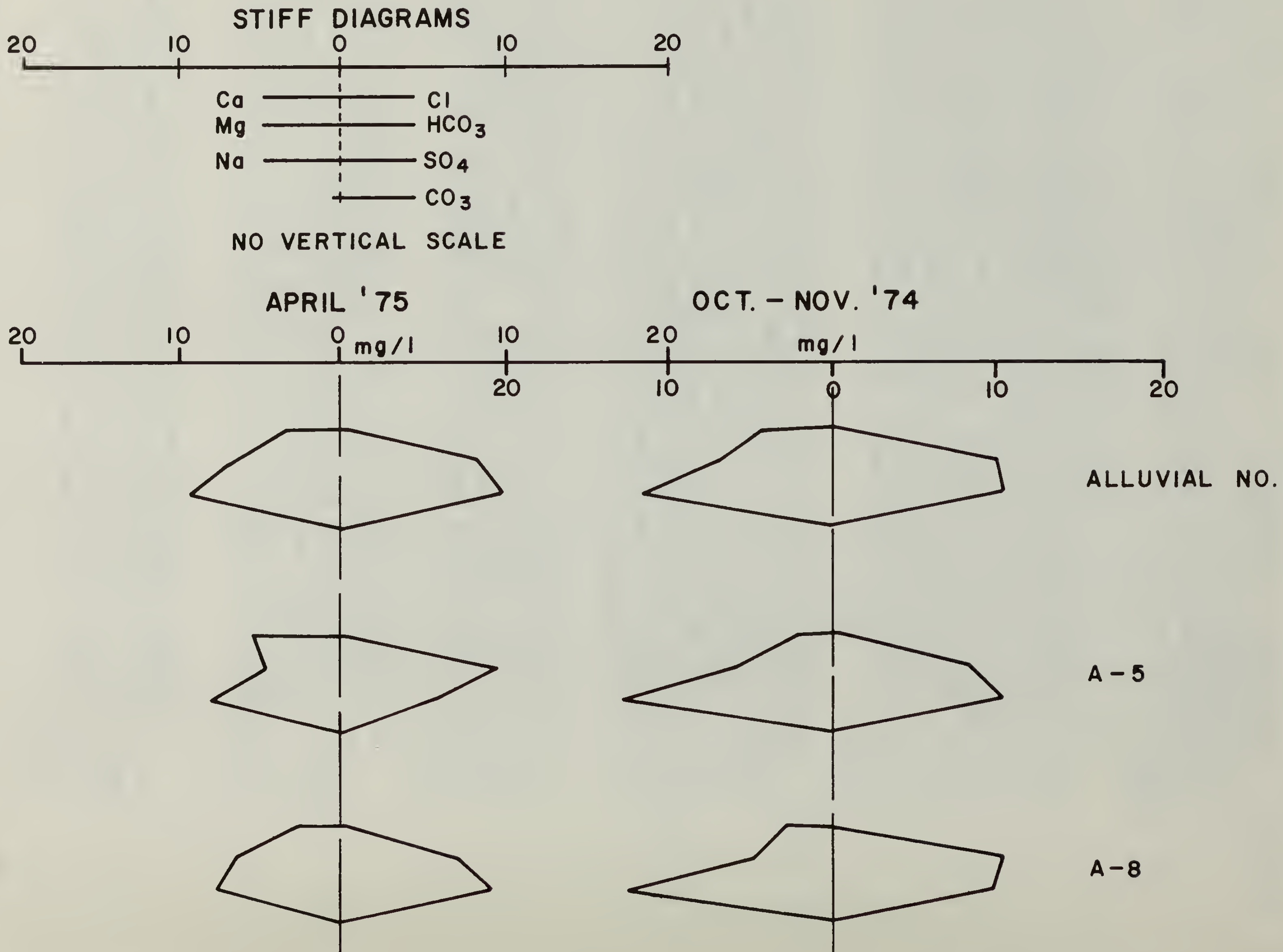


FIGURE II B-5
(SHEET 2.)

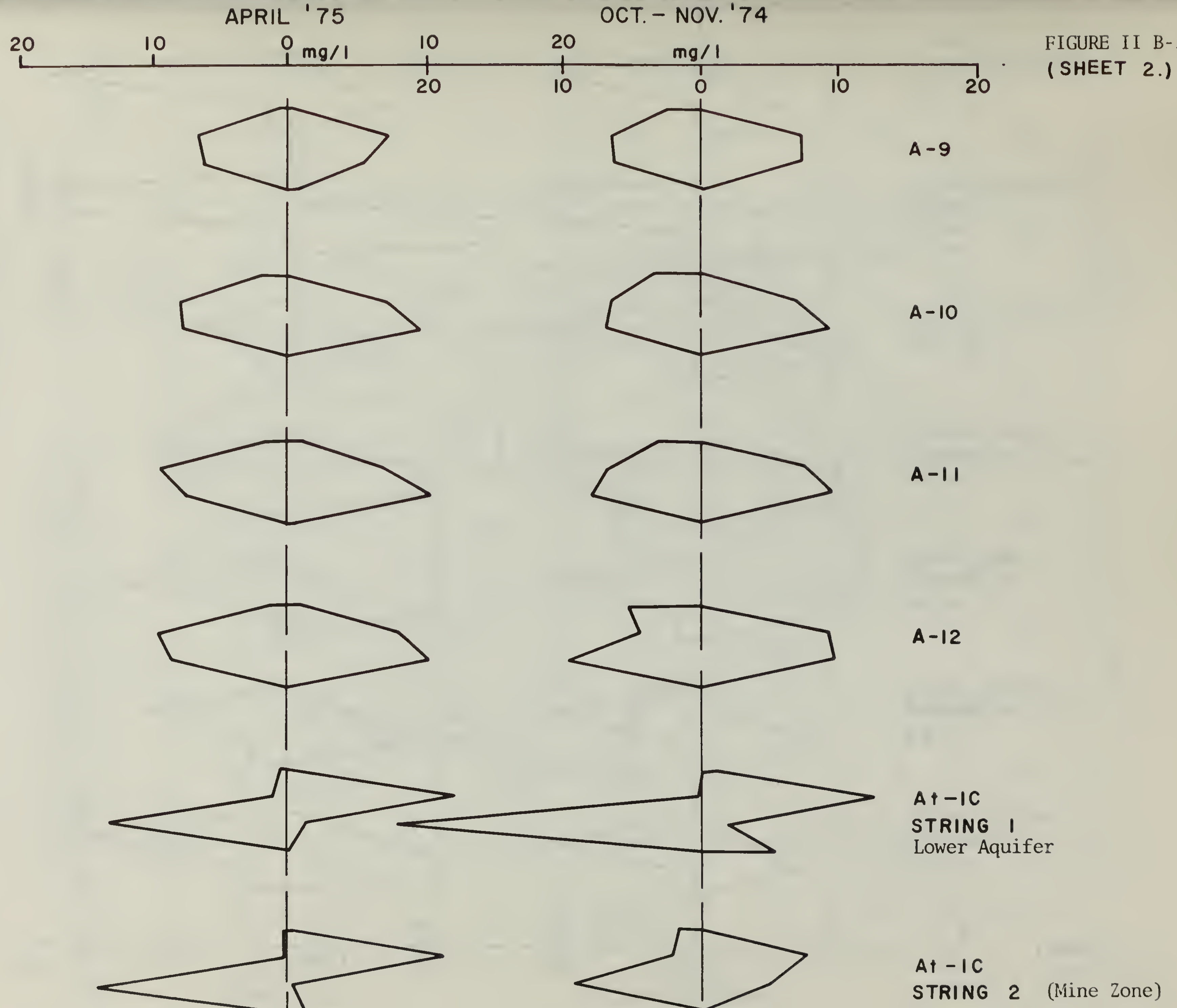
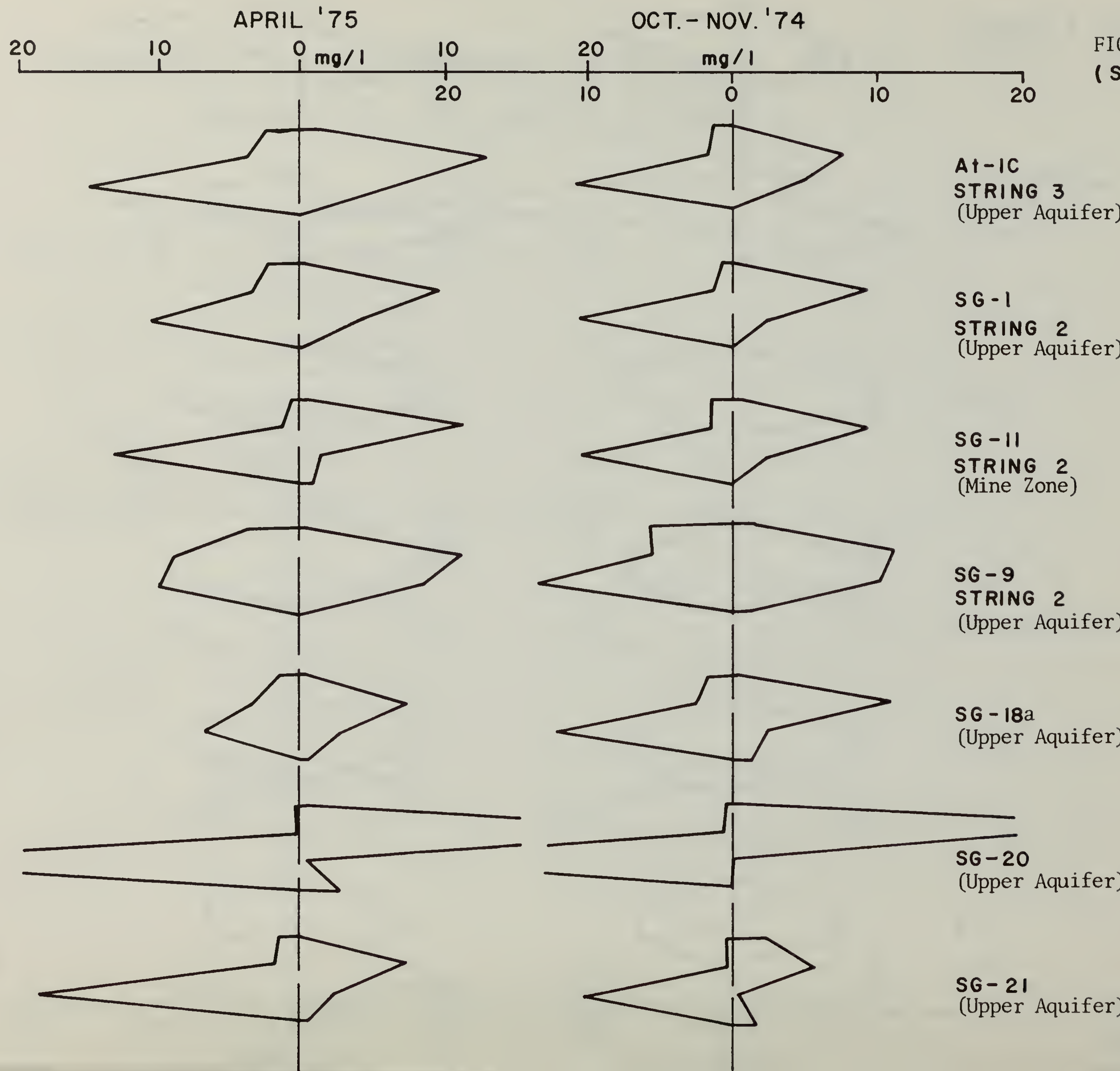
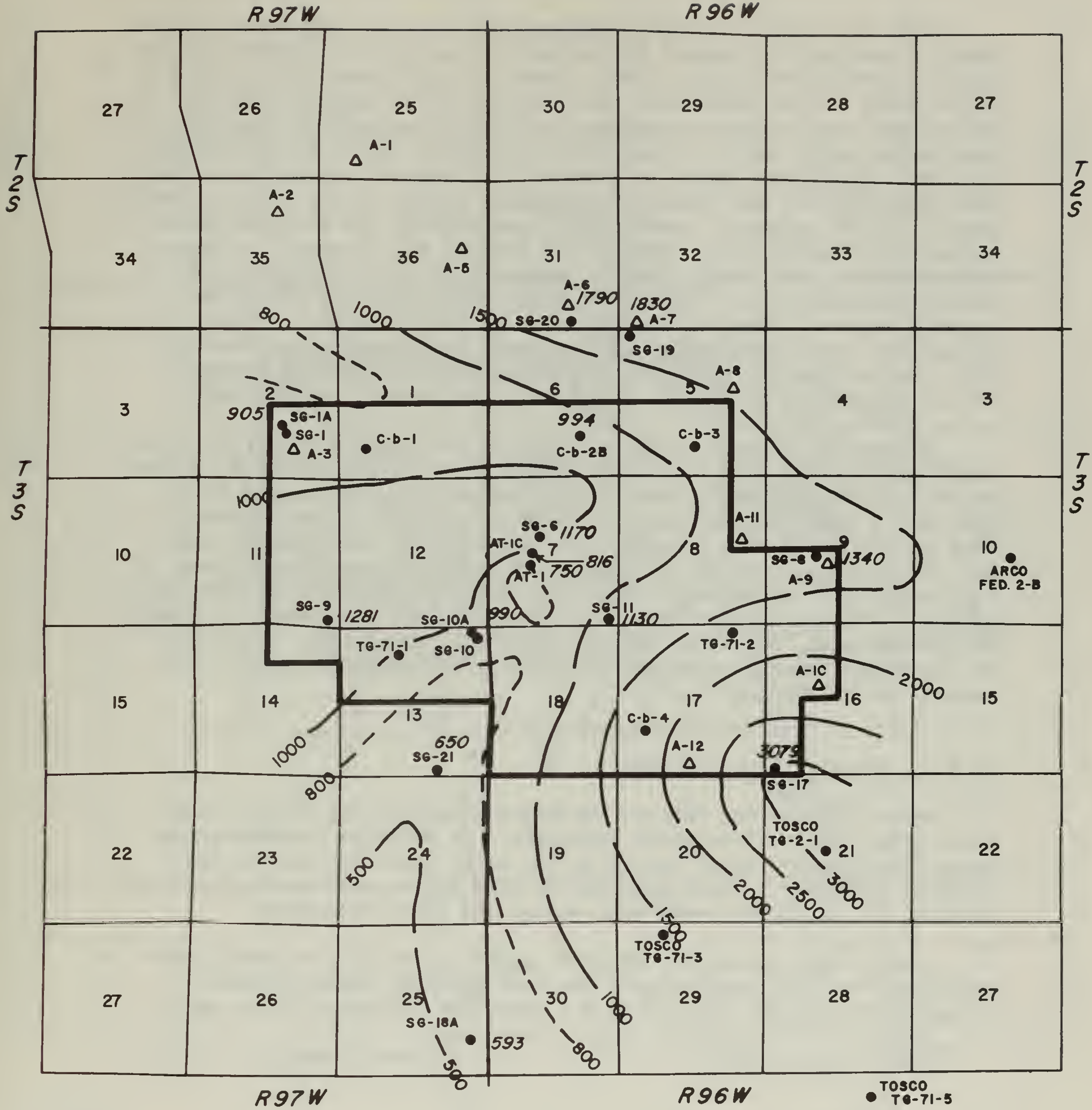


FIGURE II B-5
(SHEET 3)





LEGEND

△ ALLUVIAL WELLS

● OTHERS

ISOPLETH INTERVAL 500 mg/l

INTERMEDIATE ISOPLETHS (---) 200 mg/l

DISTRIBUTION OF TOTAL DISSOLVED SOLIDS IN THE UPPER AQUIFER SYSTEM

FIG. II B-6

There are several possible explanations for this phenomenon one of which is osmotically-induced differences in ionic concentrations across a semi-permeable membrane. Such a membrane could consist of a clay or shale facies or any other rock that exhibits a low transmissibility. If one assumes that osmosis contributes to the differences in the TDS content in the upper aquifer, then the isopleths in Figure II B-6 suggest a rather significant change in permeability along a line northeast-southwest through SG-11 and toward the southeast corner of the Tract. Continuation of this anomalous condition is seen in both the bicarbonate and sodium distribution maps. (Figures II B-7 and 8). However, in these distributions, the trough, that is, the area of least concentration, is further westward in the Tract. This representation plus the rather dramatic reversal shown in the map of calcium distribution (Figure II B-9) suggests basic differences in the causal relationships of ions and TDS. Now, as new information is generated and correlations attempted, various hypotheses to explain these basic differences can be tested.

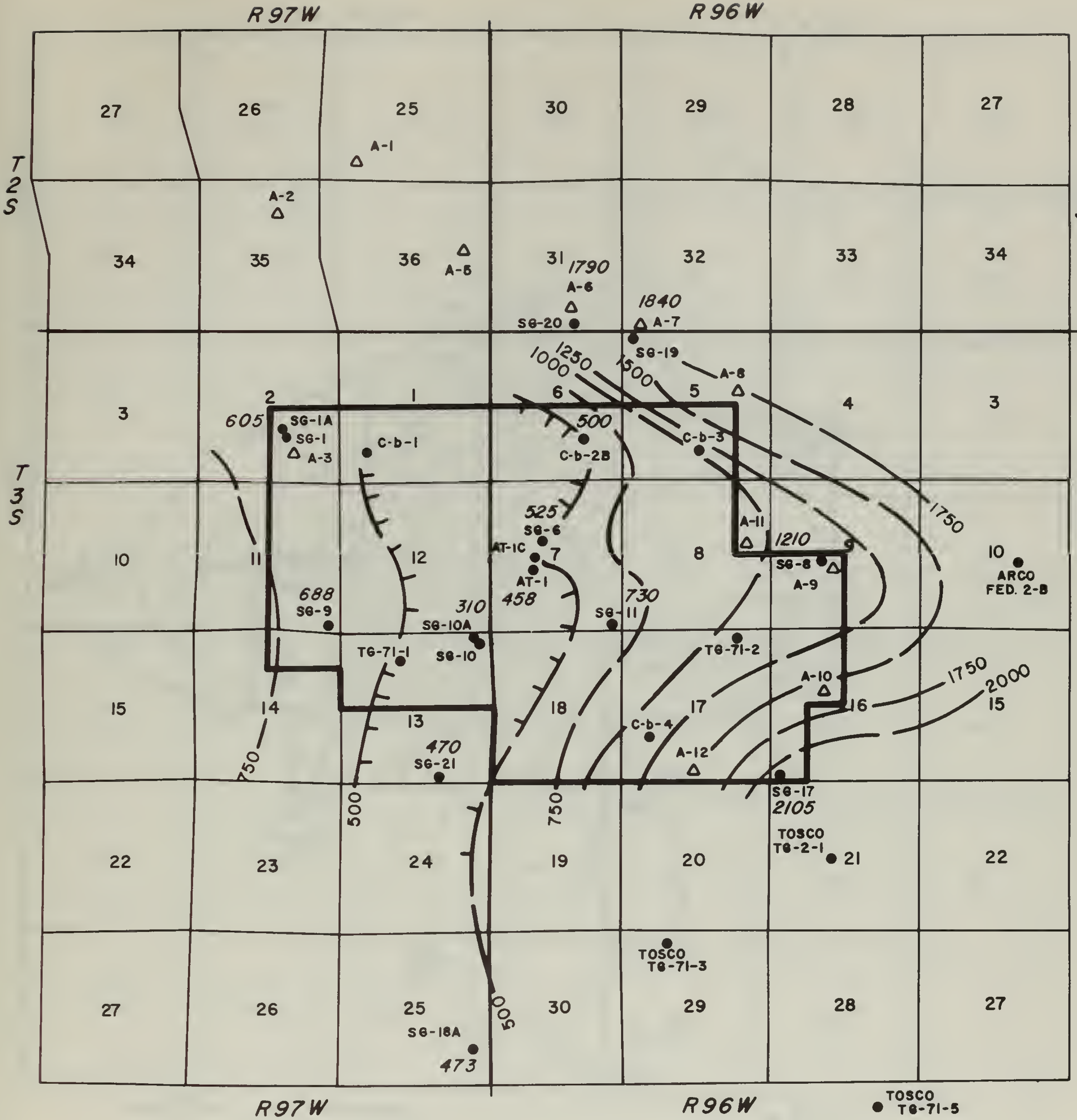
In previous reports, Summary Report #1 and Summary Report #3 it was suggested that the Parachute Creek member of the Uinta Formation exhibited stratified water conditions. A plot of selected parameters from analyses of water samples obtained from jetting tests lends support to this initial hypothesis (Figure II B-10). However, the samples from SG-6 at 20 feet and SG-18 at 35 feet are from the same section based on log correlation. Thus, it is possible that the water quality owes its apparent vertical stratification to lateral rather than vertical changes in stratigraphy. As stated above, additional correlations of data in the interface between hydrology and geology are required before a conclusion can be reached.

II B-6 Aquifer Data - General

Lease stipulations require the monitoring of water levels in the observation wells at six-month intervals. In addition to meeting the lease requirements, water levels in the wells were monitored at more frequent intervals. These data may be used in computer simulation and modeling of the aquifers for mine design and water management.

Listed below are those completed wells in which water levels were monitored since the beginning of the core drilling and associated ground water program. Figure II B-1 shows the locations of the wells.

Aquifer Test Wells	Alluvial Wells	
AT-1	A-1	A-8
AT-1B String #3	A-2	A-9
AT-1C String #1, 2 and 3	A-3	A-10
AT-1D String #1 and 2	A-4 (Dry)	A-11
	A-5	A-12
	A-6	A-13 (Dry)
	A-7	



LEGEND

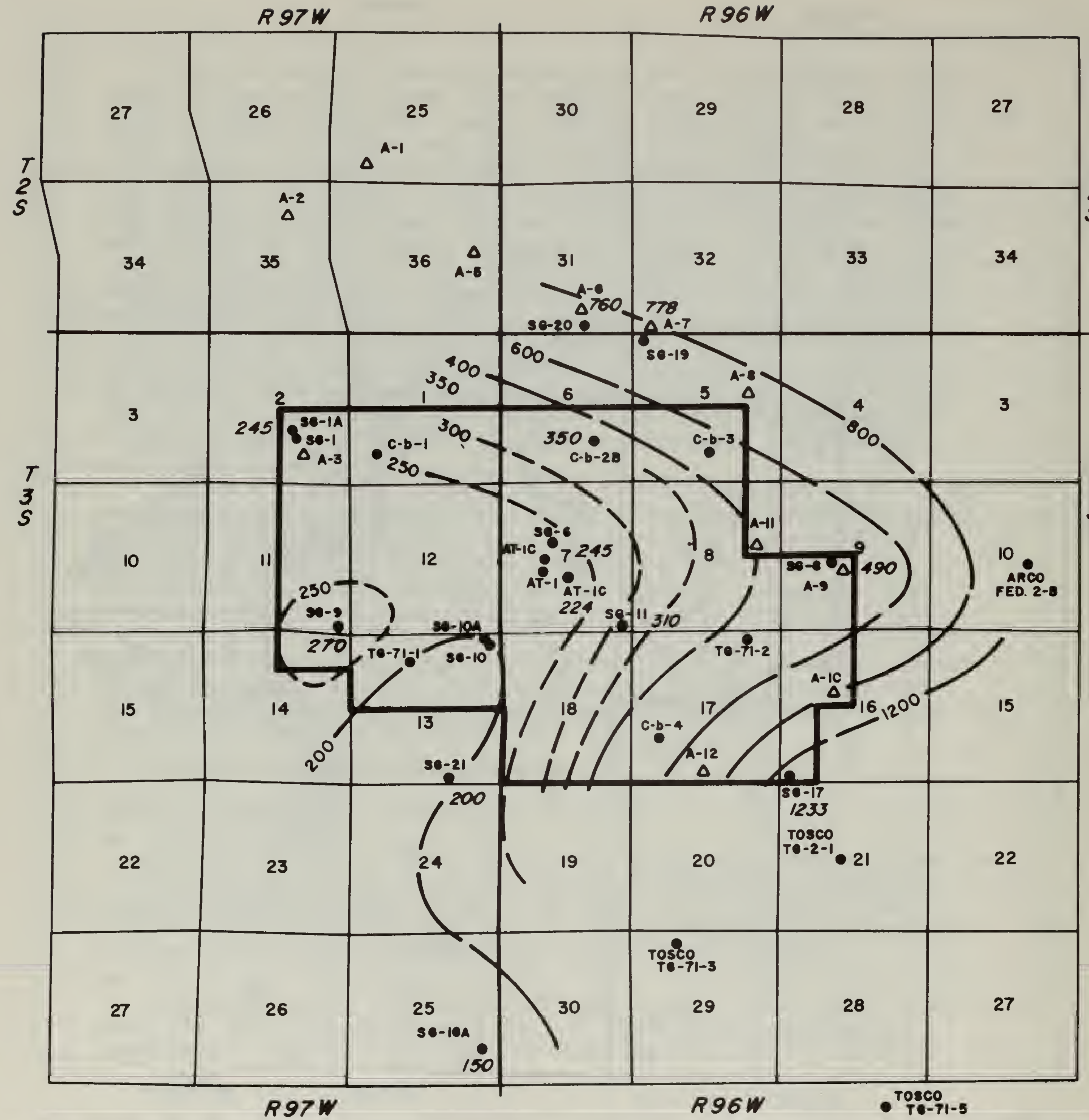
△ ALLUVIAL WELLS

● OTHERS

DISTRIBUTION OF BICARBONATE (mg/1)
IN THE UPPER AQUIFER SYSTEM

Isopleth interval 250 mg/1

FIG II B-7



LEGEND

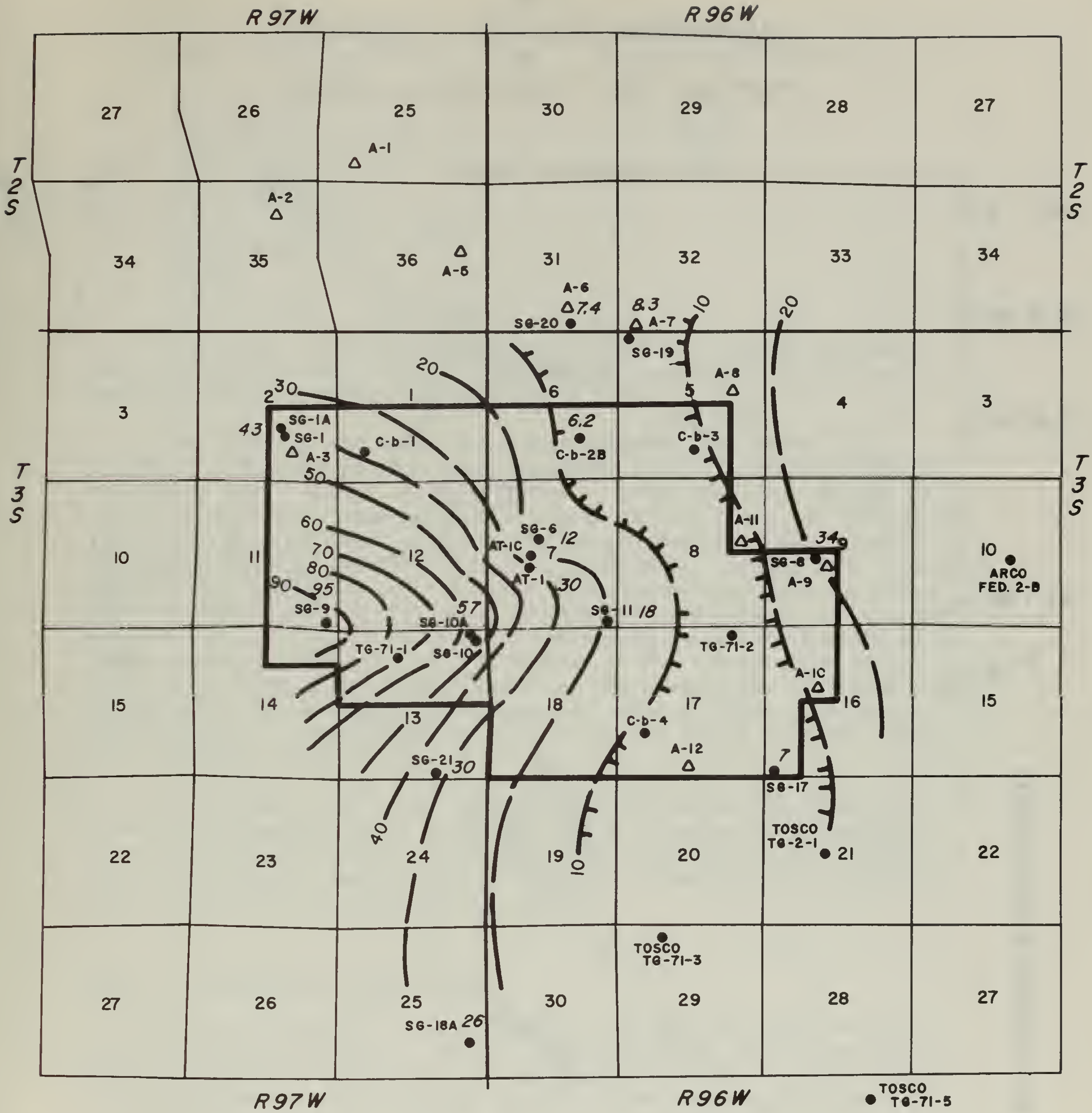
△ ALLUVIAL WELLS

● OTHERS

DISTRIBUTION OF SODIUM IN THE UPPER AQUIFER SYSTEM

Isopleth interval 200 mg/l
Intermediate isopleths (---) 50 mg/l

FIG. II B-8



LEGEND

△ ALLUVIAL WELLS

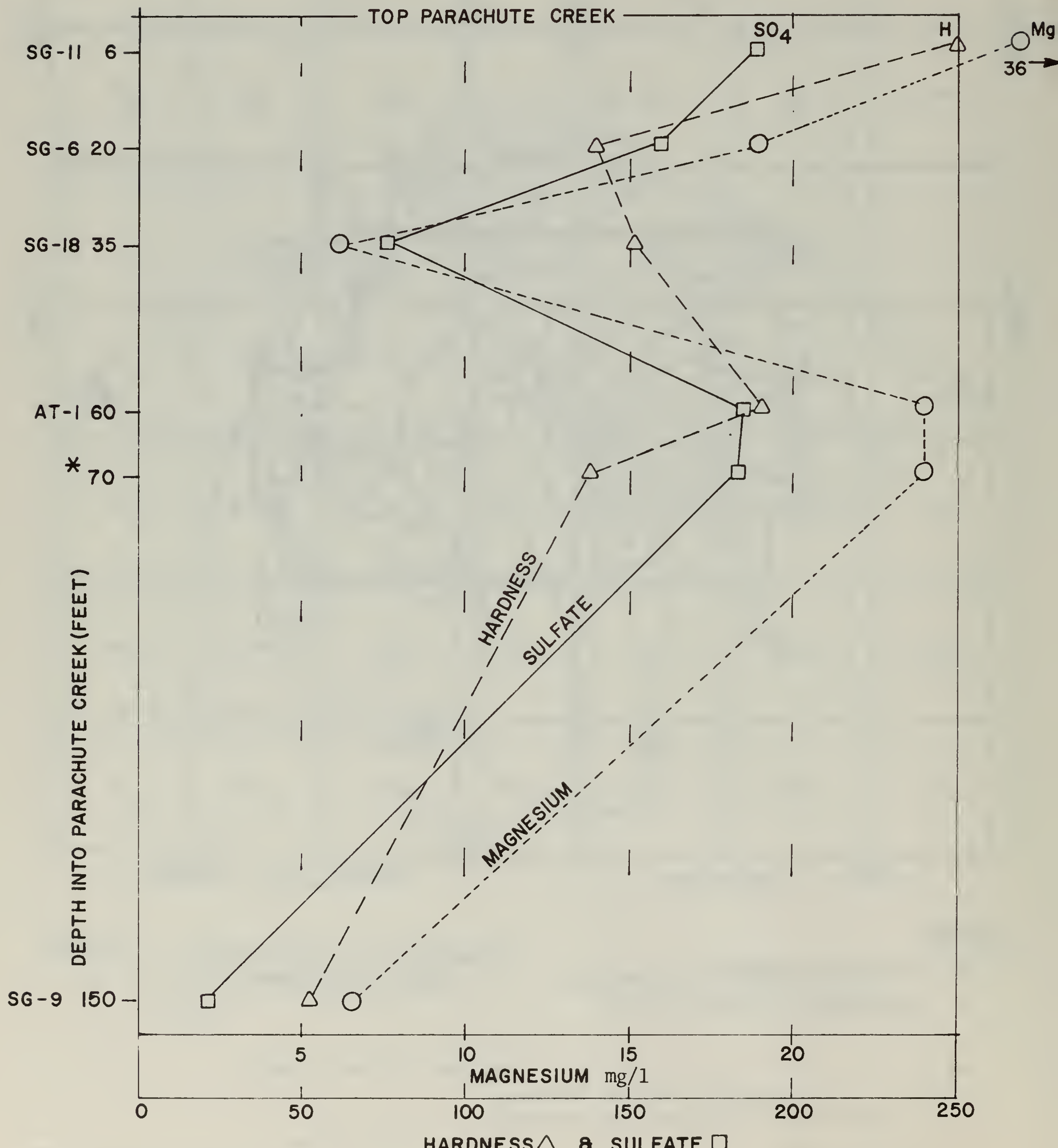
● OTHERS

DISTRIBUTION OF CALCIUM IN THE UPPER AQUIFER SYSTEM

Isopleth interval 10mg/l

FIG II B-9

VERTICAL DISTRIBUTION
OF
MAGNESIUM, SULFATE & HARDNESS
IN
TOP 150 FEET PARACHUTE CREEK



* AVERAGE OF SG-10 & AT-1a

Figure II B-10

Deep Coreholes and Wells	Existing Open Coreholes
SG-1 Strings #1 and 2	Cb-1
SG-6 Strings #1, 2 and 3	Cb-2
SG-8 Strings #1* and 2	Cb-3
SG-9 Strings #1 and 2	Cb-4
SG-10 and SG-10a	
SG-11 Strings #1, 2 and 3	
SG-17 Strings #1* and 2	
SG-18a	
SG-21	

Table II B-2 gives the summary of reduced water levels and the months of observations. Plots of water level elevations in each well are presented in Quarterly Data Report #4.

Examination of the water level data suggests that there is no hydraulic continuity between upper and lower aquifers through the Mahogany Mining Zone. Except during pump tests, water levels in Strings #1 and #2 of well AT-1c remained fairly steady from October, 1974 to August, 1975, but the water level in String #3 rose by about 12 feet. Similar phenomenon are seen in wells SG-6, SG-9, and SG-11. During June - August, 1975, in the upper aquifer, the water level in the well SG-6 was higher than the water level in well SG-9. During the same period, in the lower aquifer, the water level in SG-6 was lower than the water level in SG-9. These varying fluid levels may add support to the concept that there is no hydraulic continuity between upper and lower aquifers. Detailed study of the data with the use of potentiometric maps for upper and lower aquifers will be made during the next quarter to define the flow regime in the aquifers within the Tract.

Both the upper and lower aquifers are composed of fractured sedimentary rocks and the water holding capacity is enhanced by secondary (fracture) porosity. Modeling such an aquifer involves many complexities not encountered in sand and gravel aquifers. Extensive data on water levels will aid in developing this model.

II B-7 Aquifer Data Pumping Test

The aquifer pumping tests (including the mini-pump test) were reported in previous quarterly reports. In this report preliminary analysis is presented based upon procedures developed for quantitative analysis of drawdown in an anisotropic aquifer. The quantitative method is presented first and then the pump tests are discussed in light of the quantitative presentation.

The drawdown by pumping an anisotropic aquifer is obtained from the following considerations. Sedimentary processes, diagenesis, or struc-

* Water levels could not be measured because of obstructions in the tubing.

TABLE II B-2

SUMMARY OF WATER LEVELS
(Reduced Level in Feet)

TIME	WELL IDENTIFICATION															
	AT-1B #3	AT-1C #1	AT-1C #2	AT-1C #3	AT-1D #1	AT-1D #2	A-1	A-2	A-3	A-4	A-5	A-6	A-7	A-8	A-9	A-10
1974 June																
July																
Aug.										WELL IS DRY						
Sept.													6350.60		6492.05	6563.60
Oct.		6506.50	6510.00	6538.60	6595.00	6537.00	6236.45	6268.05	6374.10		6325.00	6325.15		6384.35		
Nov.	6536.75	6508.90	6513.00	6535.30												
Dec.							6235.85	6271.60	6376.55	WELL IS DRY	6325.75	6327.97	6351.15	6385.50	6493.00	6567.15
1975 Jan.							6235.20	6270.55	6374.05		6325.60	6325.80	6350.80	6385.90	6492.35	6565.30
Feb.																
March							6233.26	6269.05	6371.95		6323.85	6323.45	6349.90	6382.40	6490.26	6564.40
April																
May.																
June	6552.17				6500.50	6545.79	6237.99	6271.73	6377.24	WELL IS DRY	6326.51	6332.49	6354.01	6386.09	6491.74	6569.32
July							6240.03	6271.36	6372.75		6325.89	6330.01	6356.52	6385.65	6491.67	6568.36
Aug.		6508.75	6510.43	6550.10			6239.95	6270.29	6374.08		6325.72		6354.04	6385.34	6491.45	6564.65

TABLE II B-2 (Continued)

SUMMARY OF WATER LEVELS
(Reduced Level in Feet)

TIME	WELL IDENTIFICATION														
	A-11	A-12	A-13	SG-1 #1	SG-1 #2	SG-6 #1	SG-6 #2	SG-6 #3	SG-8 #1	SG-8 #2	SG-9 #1	SG-9 #2	SG-10	SG-10A	SG-11 #1	SG-11 #2
1974 June																
July			WELL IS DRY													
Aug.																
Sept.	6448.75	6636.9														
Oct.																6530.6
Nov.											6505.6	6523.99				
Dec.	6449.55	6638.92	WELL IS DRY													
1975 Jan.	6449.55	6637.85														
Feb.									FILLED WITH ORGANIC CRUD (BROWN WAXY PASTE)						UNABLE TO MEASURE	
March	6448.25	6638.45														
April																
May																
June	6449.27	6638.58	WELL IS DRY		6366.66	6487.16		6548.99		6450.18	6507.83	6521.45	6526.19	6572.23		6525.28
July	6449.14	6637.69			6367.47	6490.12		6552.55		6453.06	6521.15	6522.12	6527.04	6573.78		6503.32
Aug.	6448.97	6637.08		6364.34	6367.39	6489.90	6504.16	6559.37		6450.41	6510.98	6522.08	6487.72	6574.73		

TABLE II B-2 (Continued)

SUMMARY OF WATER LEVELS
(Reduced Level in Feet)

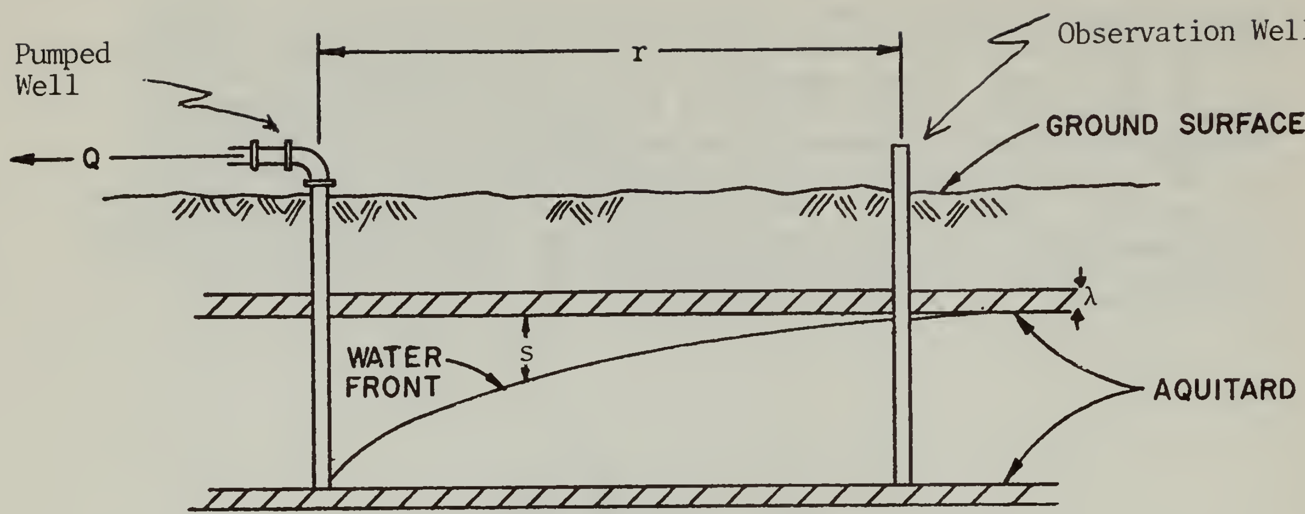
TIME	WELL IDENTIFICATION															
	SG-11 #3	SG-17 #1	SG-17 #2	SG-18A	SG-21	Cb-1	Cb-2	Cb-3	Cb-4							
1974 June							6457.35	6476.55	6621.75							
July																
Aug.																
Sept.																
Oct.	6544.00	FILLED WITH ORGANIC CRUD (BROWN WAXY PASTE)					6418.00		6616.00							
Nov.				6901.00			6404.10		6619.25							
Dec.							6398.90	6453.00	6313.75							
1975 Jan.																
Feb.																
March																
April																
May																
June	6546.04		6638.48	6899.51	6699.83	6405.51	6416.83	6416.74	6626.99							
July	6549.14		6639.92	6901.03	6713.84	6406.11	6418.33		6628.05							
Aug.			6640.92	6900.12	6703.30		6418.23		6629.14							

tural forces can work on aquifers so that permeabilities are not equal in all horizontal directions. This anisotropic characteristic should be recognized and treated separately just as the difference between vertical and horizontal permeability is recognized and treated separately. The most noticeable effect of this characteristic is the modification of the cone of depression from a circular cross-section to one that is elliptical. Equations for treating data obtained from pumping a well at a constant rate in an anisotropic aquifer are developed by Glover and reported in detail in Quarterly Data Report #4. The resulting equation is as follows:

$$s = \frac{Q}{2\pi K_1 D} \sqrt{\frac{K_1}{K_2}} \int_{\left(\frac{\sqrt{x^2 + \frac{K_1}{K_2} y^2}}{\sqrt{4\alpha t}}\right)}^{\infty} \frac{e^{-u^2} du}{u}$$

Definitions of terms used in the above equation and following text are:

- Q = discharge in gallons per minute
- r = distance (in feet) of observation well from pumped well
- s = drawdown in feet
- t = time (seconds)
- α = a constant for a given aquifer which defines the rapidity with which a transient change will take place (ft.^{2}/t)
- K = permeability; K_1 = x-direction; K_2 = y-direction
- D = an initial saturated depth (feet)
- KD = transmissivity (ft.^{2}/day)
- $\overline{V}$ = storage coefficient: the volume yield of an artesian aquifer per unit of horizontal area per unit of pressure reduction (dimensionless)
- p = permeability for vertical flow through a semi-permeable bed (feet/day)
- λ = thickness of a semi-permeable confining bed (aquitard) (feet)
- u = dummy (dimensionless) variable
- x,y = orthogonal coordinates of permeability directions (feet)



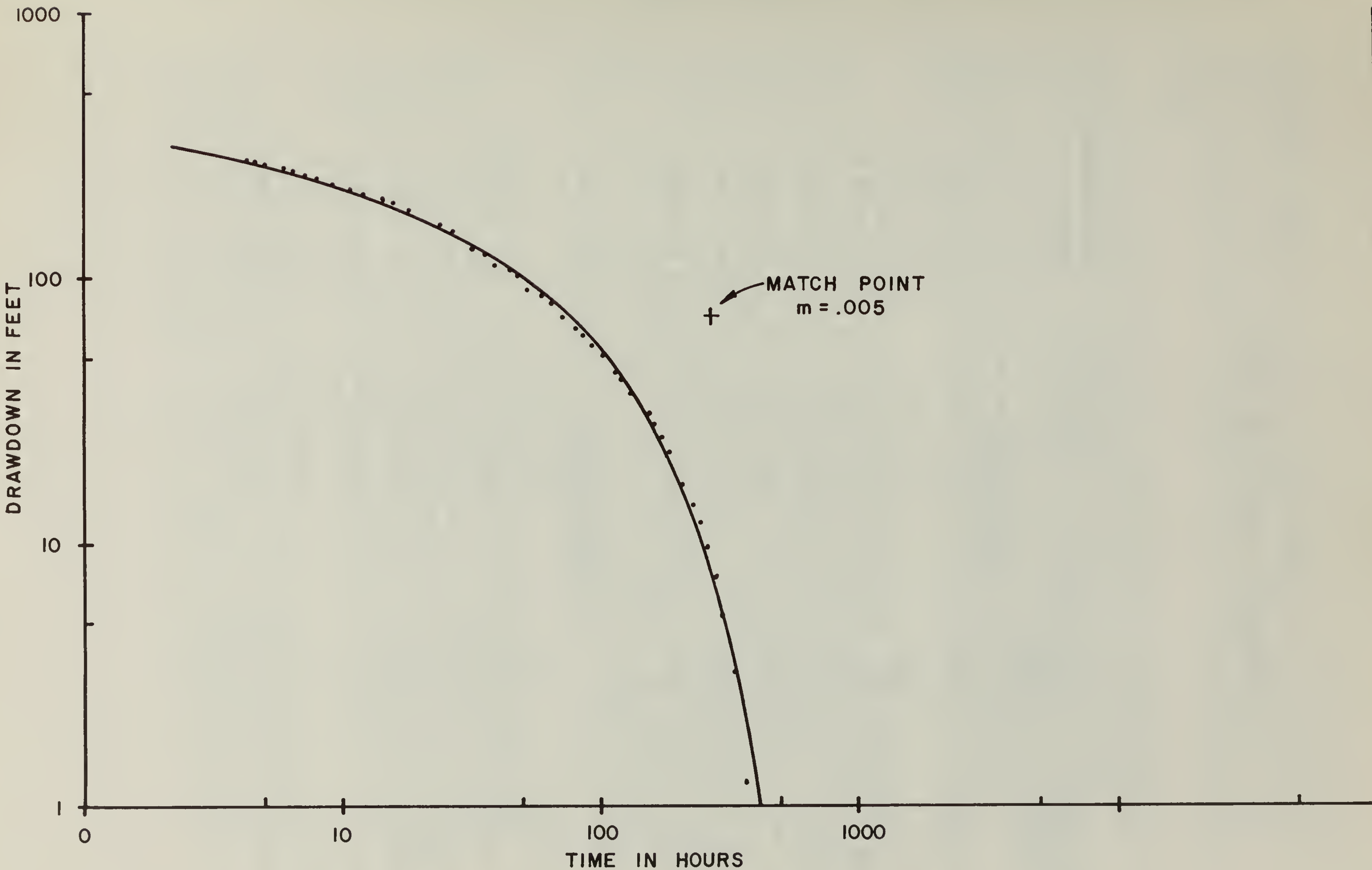
A typical indication of the "goodness-of-fit" of this equation is shown on Figure II B-11 for the drawdown of well AT-1b. The line corresponds to the above equation and the circles to the actual data points. The agreement is very good. Additional such plots are presented in Quarterly Data Report #4.

Pump Test

An extensive aquifer test was used to determine the areal hydraulics of the upper and lower aquifer and measure the vertical flow across the Mahogany Zone. Data from these tests have been reported in previous quarterly reports. These reports included field graphing and analysis for each well used in each aquifer test. The basic data obtained from these tests was reanalyzed using the leaky-artesian equations from R. E. Glover's Transient Groundwater Hydraulics.* The results of the recalculations are shown in Table II B-3.

The drawdown curves for the upper aquifer test data and the close-in wells fit the data very well. The curves of more distant wells reasonably agree with curves presented by Glover as typical of leaky-artesian conditions. For observation well layout, see Figure II B-1. The average computed transmissivity is 168 ft.^{2}/day. The greatest transmissivity value occurred in well SG-10 (233 ft.^{2}/day); the lowest

* Robert E. Glover, Transient Groundwater Hydraulics (Fort Collins, Colorado: 1974, College of Engineering, Colorado State University).



DRAWDOWN UPPER AQUIFER ATIB

Figure II B-11

TABLE II B-3

RESULTS OF AQUIFER PUMP TESTS

Well Number (String #)	Transmissivity ft^2/day (KD)	Storage Coefficient ($\overline{V}$)	Leakance/day $\left(\frac{p}{\lambda}\right)$
		UPPER AQUIFER	
AT-1a (#3)	153	4.21×10^{-4}	4.26×10^{-6}
AT-1b	162	3.71×10^{-4}	1.56×10^{-6}
AT-1c	128	2.73×10^{-4}	1.23×10^{-6}
AT-1d	130	2.97×10^{-4}	8.05×10^{-7}
SG-6	212	1.68×10^{-3}	1.27×10^{-6}
SG-10	233	4.21×10^{-4}	4.26×10^{-7}
SG-11	155	6.92×10^{-5}	5.90×10^{-7}
		LOWER AQUIFER	
AT-1a(#1)	44	4.19×10^{-4}	
AT-1c(#1)	20	1.22×10^{-4}	1.96×10^{-5}
AT-1c(#2)	41	1.21×10^{-5}	3.93×10^{-7}
AT-1d(#1)	35	2.67×10^{-5}	8.77×10^{-7}
SG-6(#1)	92	5.30×10^{-4}	8.77×10^{-7}
SG-6(#2)	36	6.48×10^{-5}	3.44×10^{-6}
SG-10(#1)	15	3.92×10^{-5}	6.88×10^{-6}

transmissivity was 128 ft.^{2}/day in well AT-1c. The storage coefficient in the upper aquifer averaged 5.05 x 10^{-4}. The maximum storage coefficient was 1.68 x 10^{-3} in well SG-6 and the lowest storage coefficient was 6.92 x 10^{-5} in well SG-11. The greatest vertical leakance was 6.1 x 10^{-6}/day in AT-1a, and the least was 4.26 x 10^{-7}/day in SG-10. The average discharge of AT-1, the pumped well, over the drawdown period was 373 gpm.

During the upper aquifer test, which produced from the entire saturated section above the Mahogany Zone, no drawdown was noted in the lower aquifer. This establishes that no vertical leakage occurred through the Mahogany Zone during this test. Figures II B-12 and II B-13, plots of the water level history of AT-1c Strings #2 and #3 during the test, indicate that no relation exists between the upper string (#3) and the lower string (#2). The fluctuation occurring in String #2 was explained by poor well completion, allowing leakage from String #1. Similar data plots are avialable in the previous quarterly reports for all strings in all wells.

The analyses of the lower aquifer drawdown test also show a good fit of the observation well data to the type curves. The transmissivity of the lower aquifer is less than that of the upper aquifer by one order of magnitude (Table II B-3). Transmissivity in the lower aquifer ranges from 14.7 ft.^{2}/day in SG-10 to 91.9 ft.^{2}/day in SG-6, String #1. The average transmissivity was 46.5 ft.^{2}/day. The storage coefficient was generally less than half as large as that of the upper aquifer. The average storage coefficient was 2.22 x 10^{-4}. The maximum storage coefficient of 5.3 x 10^{-4} was found in SG-6 String #1; the minimum of 1.21 x 10^{-5} occurred in AT-1c String #1. The computed leakance values were of the same order of magnitude as in the upper aquifer. The range was from 3.93 x 10^{-7} to 1.96 x 10^{-5}/day. The average yield of the well during this test was 120 gpm. Linear data plots similar to Figures II B-12 and II B-13 show that no water moved vertically downward through the Mahogany Zone during the pumping of the lower aquifer.

During both aquifer tests, significant anisotropic, directional flow was noted. Well SG-11 was noted to drop much more rapidly than SG-10 and SG-6 during the upper aquifer test. Computations for analyzing the drawdown relationship, using Glover's equations for anistropic analysis indicate that the greatest permeability direction for the upper aquifer may be in the east-northeast direction from the pumped well with a ratio of 9:1. Because of more limited data, the analysis of the lower aquifer can only state in general that the direction of greatest permeability lies in a more north-south direction.

The mini-pump test system, which was used on SG-1 and SG-1a, obtained the results summarized in Table II B-4. Plots of the data and corresponding analyses show a good curve fit on tests number 8 and 10. Unfortunately, the jetting system fluctuated during the initial tests number 4 and 6, and produced erratic results. The transmissivities are small even in the A-Groove (Test #10) and B-Groove (Test #8). The

FIGURE II B-12 UPPER AQUIFER TEST PRESSURE HISTORY: WELL AT-1C, STRING 3

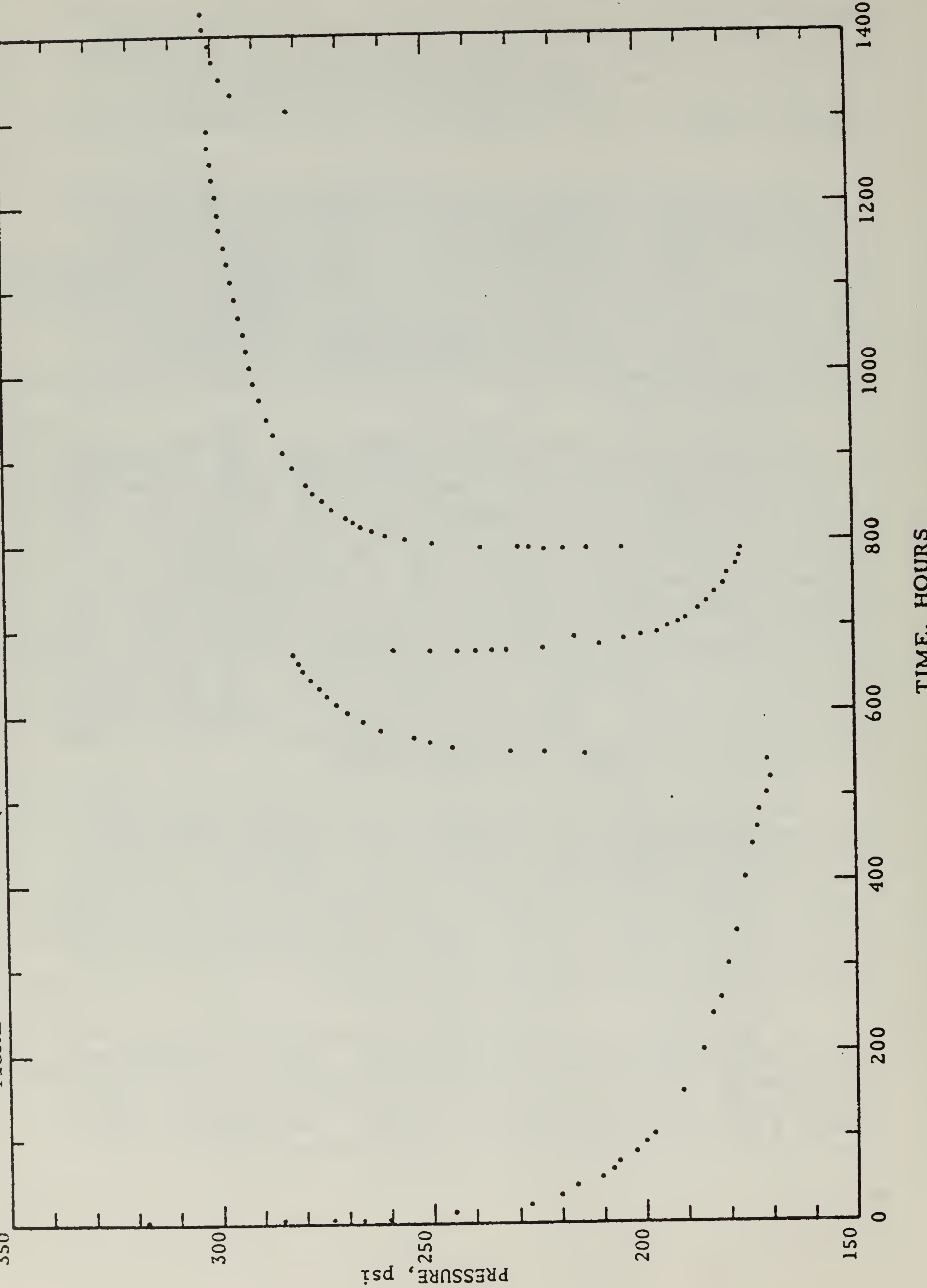


FIGURE II B-13 UPPER AQUIFER TEST PRESSURE HISTORY: WELL AT-1C, STRING 2

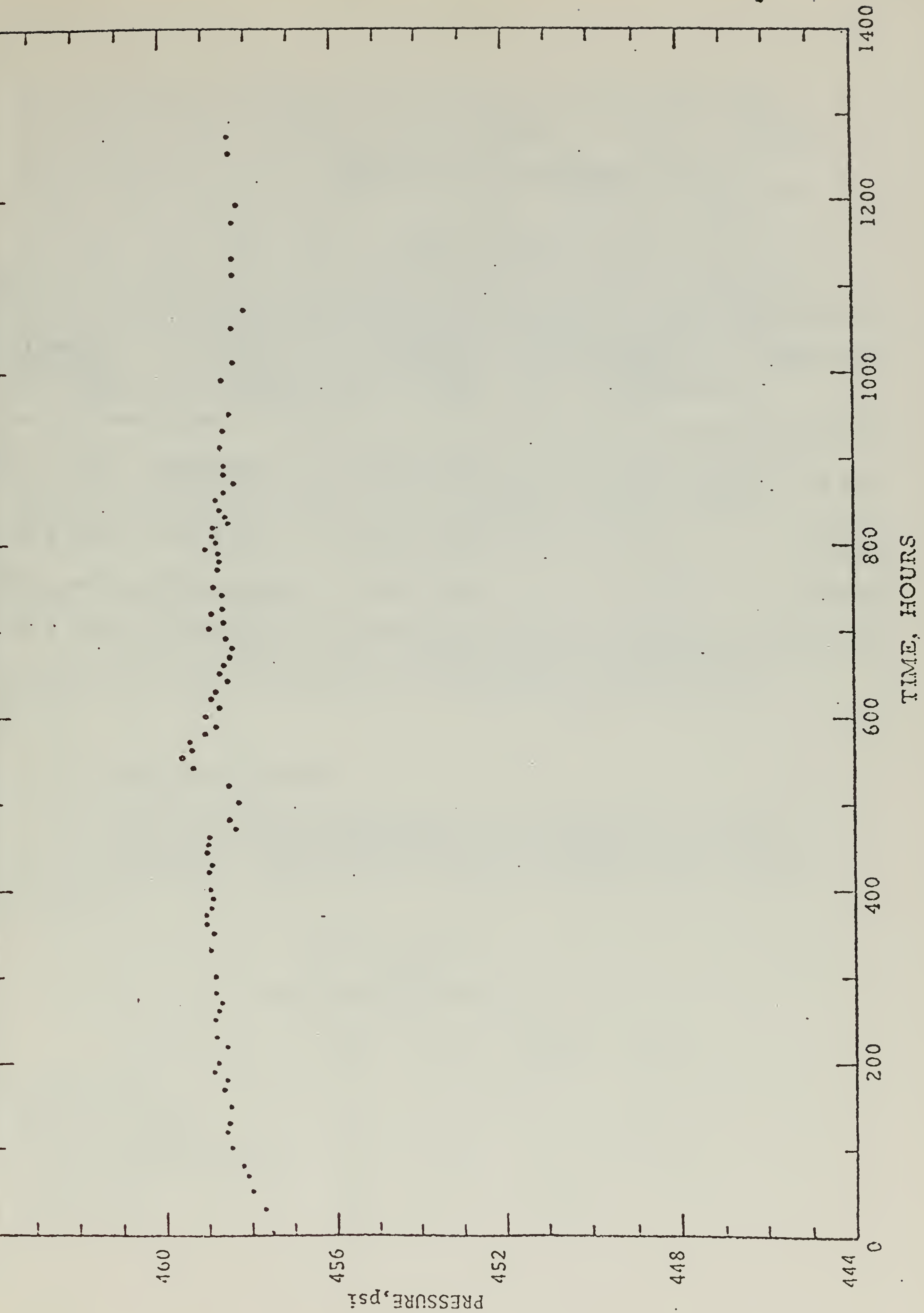


TABLE II B-4

RESULTS OF MINI PUMP TESTS

ON

SG-1 and SG-1A

Test Number	Transmissivity ft^2/day (KD)	Storage Coefficient ($\bar{V}$)	Leakance day^{-1} (p/λ)	Permeability (ft/day) (p)
Test #4	1.71	2.08×10^{-4}	3.20×10^{-7}	1.60×10^{-6}
Test #6	5.27	9.13×10^{-4}	7.58×10^{-4}	4.55×10^{-3}
Test #8	18.4	4.34×10^{-4}	1.84×10^{-5}	3.06×10^{-6}
Test #10	11.6	1.20×10^{-3}	4.63×10^{-5}	2.78×10^{-4}

range is from 1.71 ft.^{2}/day to 18.4 ft.^{2}/day. The storage coefficient is the same order of magnitude as that found in the main aquifer tests previously discussed, ranging from 2.08 x 10^{-4} to 1.20 x 10^{-3}. Leakance determinations were the main objective of these tests; computed leakance ranged from 3.20 x 10^{-7} to 7.58 x 10^{-4}/day. Vertical permeabilities, using estimated aquitard thicknesses derived from geophysical logs, ranged from 1.60 x 10^{-6} to 4.55 x 10^{-3} feet per day. From these analyses, and those of the aquifer tests, it can be seen that the leakance is a very small number and the actual vertical permeabilities are also very small. The leakance on tests number 10 and 8 is 1,000 and 25,000 times smaller than the corresponding horizontal permeabilities, respectively. The water volume produced during these tests was small, ranging from 6 to 11 gpm, owing to the limited thickness and tight confining aquitards above and below, plus the limited lifting capacity of the system. Geologic mapping has indicated that a number of these aquitards, may be continuous throughout the Tract.

Short term pumping tests were conducted in two alluvial wells near Tract C-b. The analyses using the Jacob formula from a semi-log plot indicated transmissivity values of 1350 ft.^{2}/day. Details of these analyses are available in the previous quarterly reports.

II B-8 Lithologic Log Data

All of the lithologic logs for the vertical holes have been reported in previous quarterly reports. Lithologic logs for the slant-hole program are not yet available and will be presented in subsequent reports.

II B-9 Geophysical Log Data

As stated in Quarterly Data Report #3, the geophysical log package for the vertical holes was completed with the issuance of that report. With the submittal of Quarterly Data Report the geophysical log package for the slant-hole drilling program is completed for NQ-4, NQ-7b, NQ-12d and NQ-22.

Geophysical Logs
In
Quarterly Data Report #4

	NQ-4	NQ-7b	NQ-12d	NQ-22
Electric Log	X	X	X	X
Temperature Log	X	X	X	X
Gamma Ray Neutron	X	X		X
Formation Density Log	X	X	X	X
3-Demensional Velocity Log	X	X		X
Caliper Log	X	X	X	X
Nuclear Log	X		X	

II B-10 Core Assay Data

The presentation of vertical core assay data was completed with issuance of Quarterly Data Report #3.

II B-11 Trace Element Analysis

The presentation of trace element analysis data was completed with the issuance of Quarterly Data Report #3.

II B-12 Rock Mechanics

Quarterly Data Report #3 contained the complete file for basic rock mechanics data on all vertical core holes.

II B-13 Gas Sampling Program

As discussed in previous quarterly reports, analytical results show that most gas samples collected during normal drilling operations contained only a small amount of methane gas, normally less than 5 mole percent, and very little or no ethane gas. Additional correlation and interpretation of the data collected are in progress. The results of the lower aquifer test and sampling from cores for the slant holes are discussed in the following sections.

Aquifer Test Data

As discussed in Quarterly Data Report #3, a gas-water separator was used during the lower aquifer pump test to monitor the water and gas produced from the rock strata immediately below the potential mining zone in the Mahogany Zone. As in the case of the upper aquifer(s), the gas produced from the lower aquifer(s) was in solution in the water and was produced as the water was produced. At the temperature and pressure prevailing in the lower aquifer, the ground water is capable of containing in solution approximately four times the quantity of gas that was produced for the same amount of water. So, in effect, only soluble gas was produced. The gas-water ratio was very low, measuring about one cubic foot of gas to 104 gallons of water. Results of laboratory analysis of the gas produced gave an average of 75.92 mole percent methane, 210 volumetric parts per million ethane, 0.42 and 0.15 mole percent ethylene and carbon dioxide respectively with the balance of the sample being air. Table II B-5 presents the gas sample analyses from the lower aquifer test. The gas production is plotted versus time in Figure II B-14 and the gas production per 100 gallons of water pumped is shown in Figure II B-15 for the initial drawdown phase of the lower aquifer test. Figures II B-16 and II B-17 show the same information for the pulse phase of the lower aquifer test.

TABLE II B-5
AT-1 LOWER AQUIFER PUMP TEST DATA

Time (Military Time in Hours)	Elapsed Time		GAS METER Reading ft^3	GAS METER cu.ft. prod.	Measured Flow Rate Ft.^{3}/Min.	Cu. Ft./Min Corrected To 1.18 Meter	Cu. Ft./Min Corrected To 1.18 Meas.	WATER Flume Reading	WATER GPM	Meter ft^3/100 gal.	Meas. ft^3/100 gal
	Min	Hr									
2-23-75											
11:30	0	0	606.0	--	1.2	--	1.42	.29	130.1	--	1.09
2-24-75											
10:00	1350	22.5	--	--	1.2	--	1.42	.27	116.7	--	1.22
12:00	120	24.5	--	--	1.2	--	1.42	.27	116.7	--	1.22
2-25-75											
9:10	1270	45.6	682.1	1076.1	---	1.00	---	.27	116.7	0.86	---
11:50	160	48.3	687.0	4.9	---	.04	---	.27	116.7	---	---
16:20	270	52.8	864.9	177.9	---	0.78	---	.28	125.7	0.62	---
22:10	350	58.6	211.5	346.6	---	1.17	---	.28	125.7	0.93	---
2-26-75											
8:50	640	69.3	582.5	371.0	---	0.68	---	.27	116.7	0.58	---
18:00	550	78.5	795.0	212.5	---	0.46	---	.28	125.7	0.37	---
23:00	300	83.5	107.5	312.5	---	1.23	---	.27	116.7	1.05	---
2-27-75											
09:00	600	93.5	--	--	.95	--	1.12	.26	112.2	--	0.99
11:25	745	95.9	856.5	749.0	.92	1.19	1.08	.28	125.7	0.95	0.86
19:55	510	104.4	205.0	348.5	---	0.81	---	.27	116.7	0.69	---
2-28-75											
5:45	590	114.2	21.0	816.0	---	1.63	---	.27	116.7	1.40	---
10:00	255	118.5	378.4	357.4	---	1.65	---	.28	125.7	1.31	---
15:00	300	123.5	693.0	314.6	1.0	1.24	1.18	.28	125.7	0.99	0.94
20:00	300	128.5	893.0	200	---	0.79	---	.27	116.7	0.68	---
3-1-75											
00:40	280	133.2	296.0	403	1.1	1.70	1.30	.27	116.7	1.46	---
6:50	370	139.4	689.0	393	---	1.25	---	.27	116.7	1.07	---
11:17	247	143.5	861.8	172.8	1.0	0.83	1.18	.27	116.7	0.71	---
16:00	283	148.2	145.6	283.8	---	1.18	---	.27	116.7	1.01	---
21:00	300	153.2	440.5	294.9	---	1.16	---	.27	116.7	0.99	---
3-2-75											
2:00	300	158.2	735.0	294.5	1.0	1.16	1.18	.27	116.7	0.99	---
6:50	290	163	45.0	310.0	1.0	1.26	1.18	.27	116.7	1.08	---
11:45	295	167.9	468.9	423.9	---	1.70	---	.28	125.7	1.35	---
14:10	245	172.0	---	---	1.08	---	1.27	.28	125.7	---	1.01
3-3-75											
2:45	755	184.6	390.0	921.1	1.0	1.09	1.18	.27	116.7	0.93	---
7:50	305	189.7	603.0	213.0	1.0	0.82	1.18	.27	116.7	0.70	---
12:45	295	194.6	936.7	333.7	1.0	1.34	1.18	.28	125.7	1.07	0.94

TABLE II B-5 (Continued)

Time (Military Time in Hours)	Elapsed Time		Measured GAS METER Read-ing ft^3	cu.ft. prod.	Flow Rate $Ft.^3$	Cu. Ft./Min Corrected to 1.18 Meter	Meas.	WATER Flume Read-ing	GPM	Meter $\frac{ft^3}{100 \text{ gal.}}$	Meas. $\frac{ft^3}{100 \text{ gal.}}$
3-4-75	Min.	Hr.									
3:45	900	209.6	838.0	901.3	1.0	1.18	1.18	.28	125.7	0.94	0.94
9:00	315	214.9	098.5	260.5	--	0.98	--	.29	130.1	0.75	--
14:00	300	219.9	396.0	297.5	--	1.17	--	.28	125.7	0.93	--
3-5-75											
9:50	1190	239.7	686.0	1290.0	--	1.28	--	.28	125.7	1.02	--
14:55	305	244.8	907.5	221.5	--	0.86	--	.28	125.7	0.68	--
3-6-75											
12:00	1265	265.9	45.5	113.8	--	1.06	--	.28	125.7	0.84	--
14:00	--	--	558.8	--	1.1	--	1.30	.28	125.7	--	1.03
17:00	300	270.9	483.5	438	--	1.72	--	.28	125.7	1.37	--
22:00	300	275.9	735.0	251.5	--	0.99	--	.28	125.7	0.79	--
3-7-75											
08:00	600	285.7	441.5	706.5	--	1.39	--	.28	125.7	1.11	--
13:00	300	290.9	779.0	337.5	1.18	1.33	1.39	.28	125.7	1.06	1.11
3-8-75											
13:20	1460	315.2	--	--	1.17	--	1.38	.28	125.7	--	1.10
18:00	280	319.9	133.0	1354.0	--	0.92	--	.28	125.7	0.73	--
23:00	300	324.9	449.0	316.0	--	1.24	--	.28	125.7	0.99	--
3-9-75											
09:00	600	334.9	--	--	1.08	--	1.27	.28	125.7	--	1.01
19:00	600	344.9	885.0	1569	--	1.54	--	.28	125.7	1.23	--
24:00	300	349.9	211.0	326	--	1.28	--	.28	125.7	1.02	--
3-10-75											
05:00	300	354.9	351.5*	--	--	--	--	.28	125.7	--	--

Arithmetic Average = .958 $\frac{ft^3}{100 \text{ gal.}}$

* Meter Frozen - read after thawing (Data not Applicable)

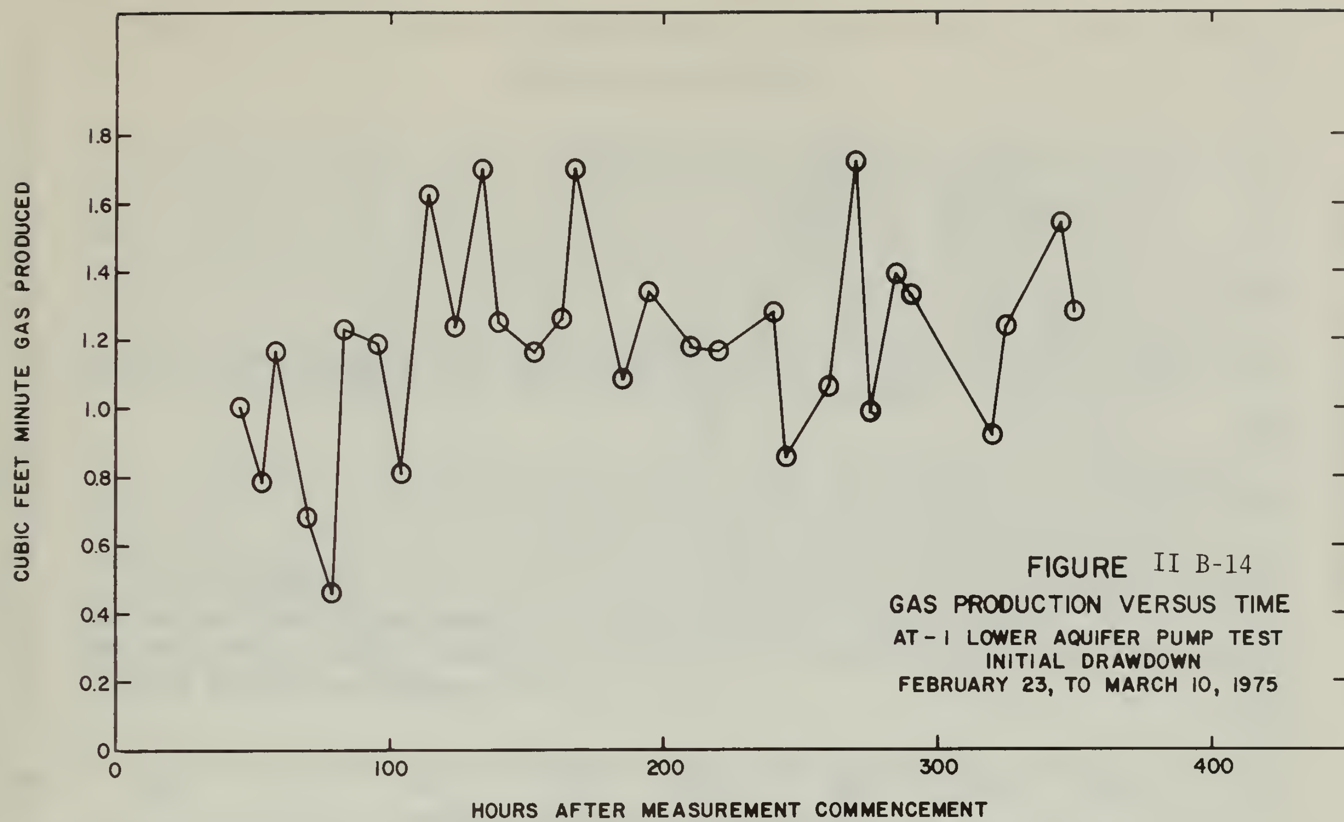


FIGURE II B-14
GAS PRODUCTION VERSUS TIME
AT-1 LOWER AQUIFER PUMP TEST
INITIAL DRAWDOWN
FEBRUARY 23, TO MARCH 10, 1975

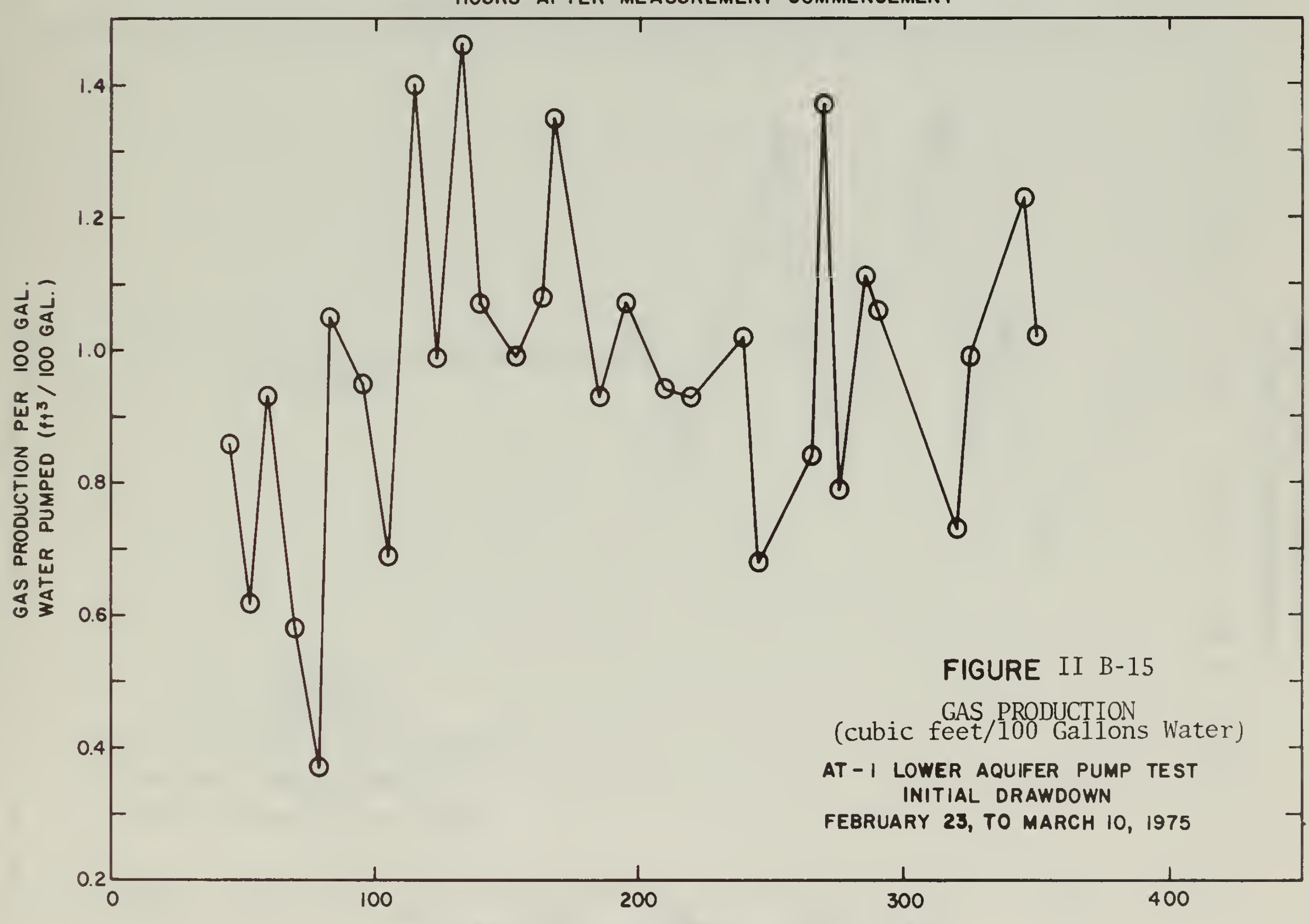


FIGURE II B-15
GAS PRODUCTION
(cubic feet/100 Gallons Water)
AT-1 LOWER AQUIFER PUMP TEST
INITIAL DRAWDOWN
FEBRUARY 23, TO MARCH 10, 1975

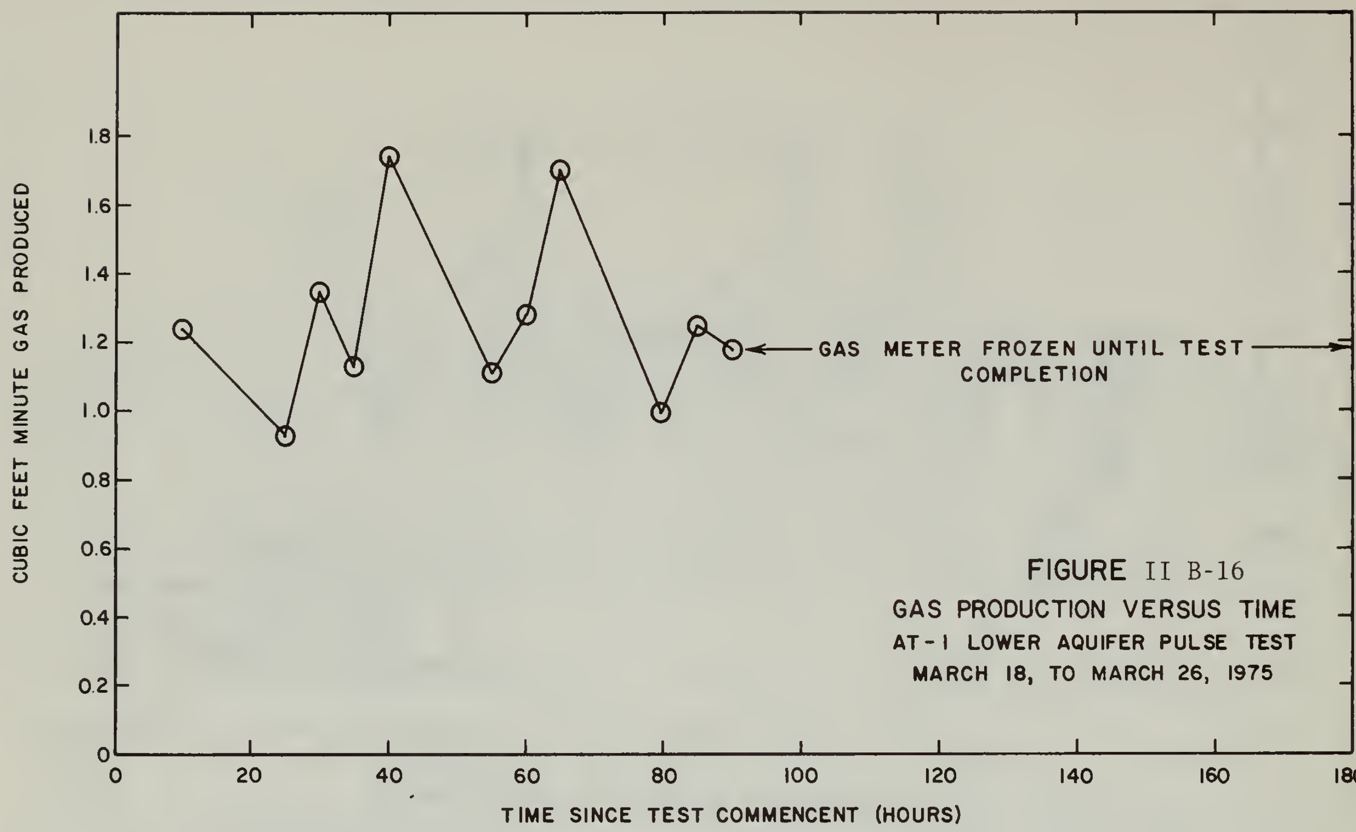


FIGURE II B-16
GAS PRODUCTION VERSUS TIME
AT-1 LOWER AQUIFER PULSE TEST
MARCH 18, TO MARCH 26, 1975

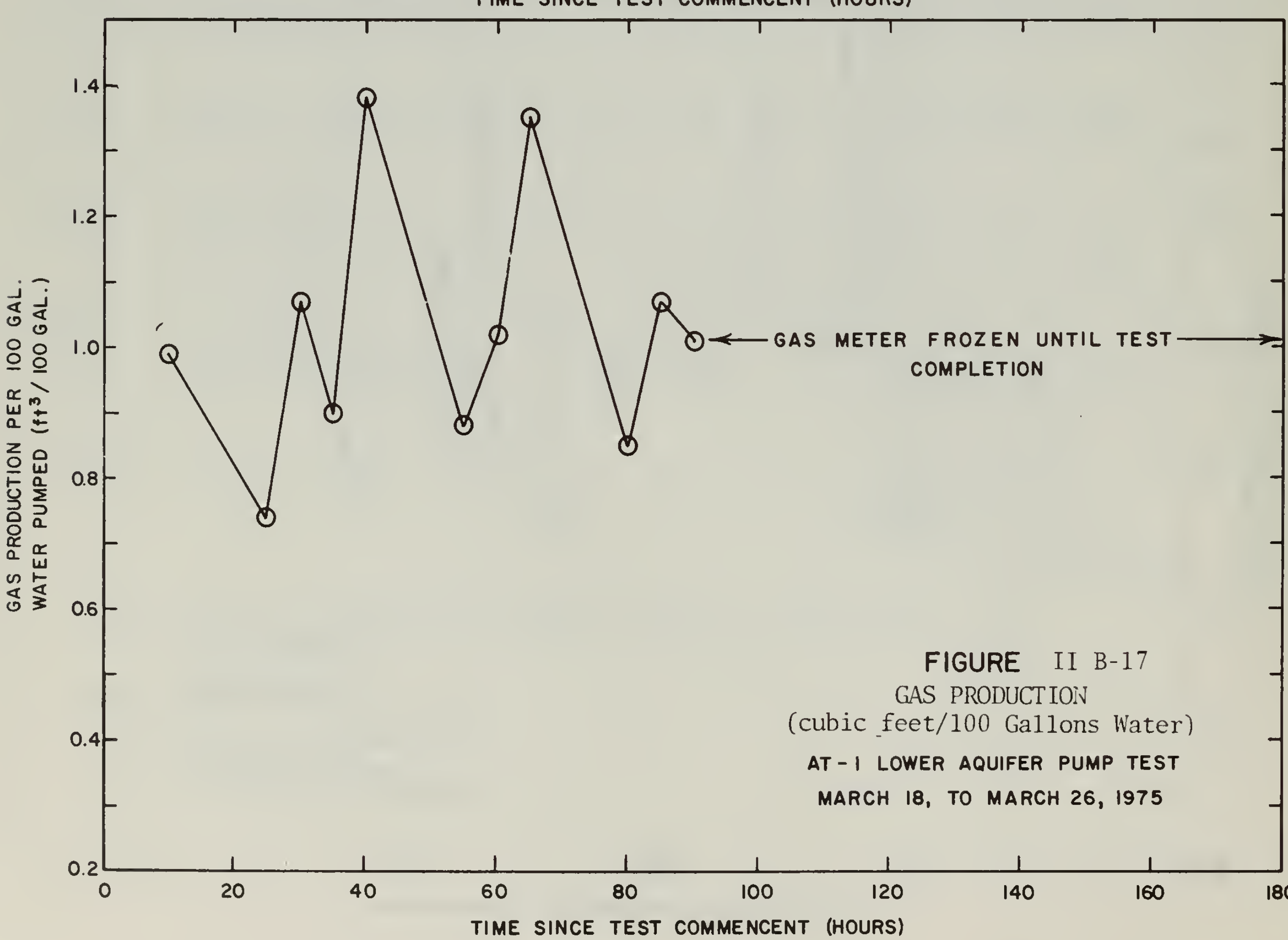


FIGURE II B-17
GAS PRODUCTION
(cubic feet/100 Gallons Water)
AT-1 LOWER AQUIFER PUMP TEST
MARCH 18, TO MARCH 26, 1975

Sampling From Cores

The method described in Quarterly Data Report #3 under the heading "Sampling From Cores" has been used on slant core holes at Tract C-b. For details of the method please refer to Quarterly Data Report #3, II B-15. Data in Quarterly Data Report #4 present the results of the measurements made in the field from cores from NQ-4, NQ-7b, NQ-12d, and NQ-22. These cores are currently being crushed and tested to determine the amount of residual gas left in the core; results are not available for inclusion in the Quarterly Data Report. Table II B-6 presents the analysis of gas samples from Tract C-b, May, 1975 - August, 1975.

Fifteen core intervals (14 of which were oil shale cores) from the slant holes have been tested in the field for gas emission. No emission occurred in thirteen of the cores and only a very small amount in the other two, 58 ml. and 22 ml. in cores from NQ-7b. Laboratory analysis of the sample collected from the core which evolved 58 ml. revealed that this gas was 0.19 mole percent methane and the remainder was air. Analysis also showed that all of the 22 ml. which evolved from the other sample were air (Refer to Table II B-7).

TABLE II B-6

ANALYSIS OF GAS SAMPLES FROM TRACT C-b

MAY, 1975 - AUGUST, 1975*

Core Hole	Description	Date	Depth Ft.	Methane Mole%	Ethane Mole%	CO_2 Mole%	CO Mole%	Balance Air
SG#11	String No. 1 5:45 hrs.	4-7-75	ND	95.29	0.10	3.70	0.10	Air
NQ-4b	1700 Hours Mahogany Mark	6-1-75	1375	-	-	-	-	Air
NQ-7b	1335 Hours Mahogany Mark At Well Head	7-6-75	1553	<1ppm	-	0.07	-	Air
	Gassy Core Test	7-6-75	1552.5 to 1555	0.66	-	-	-	Air
	Gassy Core Test	7-6-75	1563.1 to 1565.1	-	-	-	-	Air
	1228 Hours At Well Head	7-7-75	1611.5	-	-	-	-	Air
NQ-12d	Mine Zone 12:30 a.m.	5-18-75	1470	ND	ND	ND	ND	Air
	Mine Roof 1310 hrs.	5-17-75	1449	ND	ND	ND	ND	Air
	"B" Groove 0230 hrs.	5-21-75	1617	ND	ND	ND	ND	Air

ND = Not detectable
* = No H_2, H_2S, N_2, O_2 or heavier hydrocarbons were found in any of the samples.

TABLE II B-7

GAS SAMPLE ANALYSIS LOWER AQUIFER TEST

Date and Description	Methane (mole %)	Ethane (Vppm)	Ethylene (mole %)	CO_2 (mole %)	Balance Air
2-16-75	72.12	200	0.39	---	Air
3-6-75 1400 Hr.	77.47	229	---	0.15	Air
Lower Aquifer Drawdown 3-9-75 1500 Hr.	78.43	100	---	0.15	Air
Average Value Initial Drawdown	76.01	176	---	0.15	Air
Lower Aquifer Pulse Test 3-26-75	75.67	311	0.45	0.16	Air
Average All Values	75.92	210	0.42	0.15	Air

II C AIR QUALITY

The current air quality/meteorology network is shown on Figure II C-1 and now includes five air quality trailers, the meteorological tower, two acoustic sounders, three ground-level mechanical weather stations and an area-wide visibility site. Trailers 020, 021 and 022 are located in the Piceance Creek Valley at Redd Ranch, Rock School, and the Gerald Oldland Ranch, respectively. Trailers 023 and 024 are located on the Tract plateau. The sounders are co-located with Trailers 021 and 023. The mechanical weather stations are located in the Piceance Valley in Section 9 (T2S,R98W) near Dudley Bluffs (MRI 1), on the northwest corner of the Tract in Section 2 (T3S,R97W) near Scandard Gulch (MRI 2) and near the southern edge of the Tract in Section 17 (T3S,R96W) near the West Fork of Stewart Gulch (MRI 3). The visibility site is in Section 30 (T3S,R98W) along the Hunter Creek road near Dry Gulch. The reader is referred to Tables II C-1 and II C-2 of the Quarterly Data Report #4 for specific data measurements and sampling frequencies.

The air quality discussion is divided into paragraphs as follows: Air Quality and Surface Meteorology, Low Altitude Meteorology, Upper Air Studies, Visibility, Noise, and Atmospheric Diffusion Studies.

II C-1 Air Quality and Surface Meteorology

Tables II C-1 through II C-5 summarize the maximum concentrations for the gases and particulates from March through May that correspond to the appropriate time intervals as determined by State and Federal regulations. Table II C-6 is the frequency distribution by concentration per trailer for particulates and shows the geometric mean for the three months. Tables II C-7 through II C-15 tabulate the monthly maximum, sliding one-hour average. In the case of the non-methane hydrocarbons and the particulates, these maximums are for the 6:00 - 9:00 a.m. interval and 24 hour period, respectively. These are shown with the corresponding date, time of day, wind direction, and speed. Monthly averages follow on Table II C-16.

The May, June, and July sulfur dioxide (SO_2) and hydrogen sulfide (H_2S) monthly one-hour maximums are reported in Tables II C-7 and II C-8, respectively, and the monthly averages are given in Table II C-16. A review of the Radian monthly data reports indicates that the majority of the measurements show ambient air concentrations below the 5ppb minimum detectable limit of the instrumentation. However, ambient air concentrations well above the 5ppb level are occasionally recorded. This is occasionally recorded as can be seen in Tables II C-7 and II C-8. In fact, in the three-month period, May to July, new maximum values of SO_2 were recorded at all valley trailers. New low values were recorded at valley Trailers 021 and 022. Similarly, new low values for concentrations of H_2S were recorded at all valley trailers as well as plateau Trailer 024. Both plateau trailers recorded new maximum values as did valley Trailer 020. As of this time, no trend can be seen in the maximum or minimum recordings of either gas.

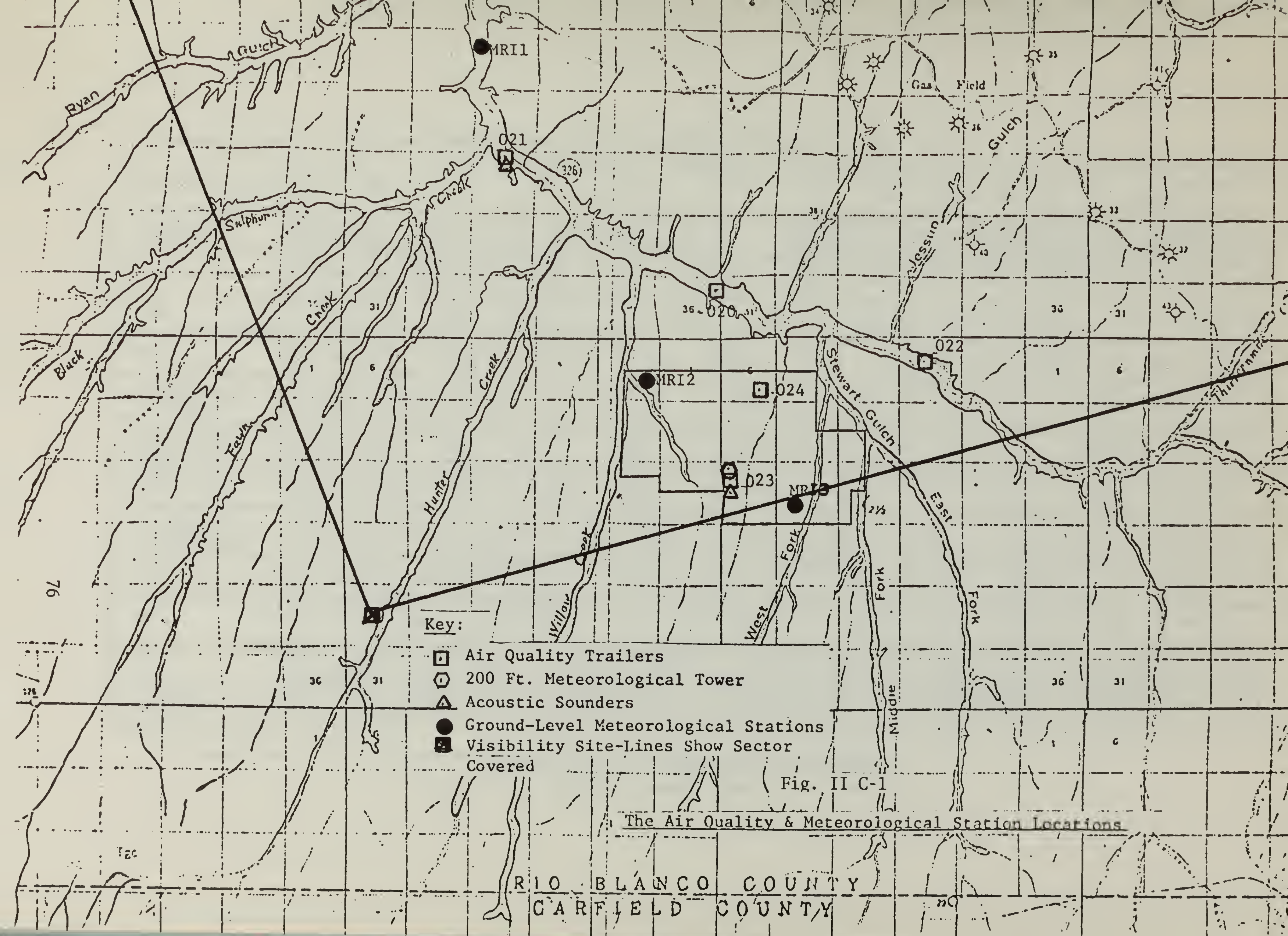


Fig. II C-1

The Air Quality & Meteorological Station Locations

TABLE II C-1 QUARTERLY SUMMARY (March '75 - May '75)
(Concentrations in micrograms per cubic meter)

TRAILER No. 20

Recorded Parameter	Average	Maximum 24-hr. Concentration		Maximum 8-hr. Concentration		Maximum 3-hr. Concentration		Maximum 1-hr. Concentration		Maximum 5-min. Concentration	
		Value	Time	Value	Time*	Value	Time*	Value	Time*	Value	Time*
SO_2	.4	30.2	3/7 10:00			31.5	3/7 9:50	32.8	3/7 10:05	138.1	3/31 18:20
H_2S	.1							12.5	3/7 10:05	26.3	3/7 10:10
Particulates	9.8	89.0	4/25								
Total Hydro-carbons	921.7					2200.8	5/20 6:00			3179.3	5/1 23:55
CH_4	753.6					998.8	3/5 6:00			2864.8	5/1 23:50
Non-CH_4 Hydrocarbons	137.9					707.7	4/22 6:00			1314.2	3/16 13:00
O_3	77.8							146.2	3/26 9:00	314.5	3/15 14:05
NO_x	15.0							35.7	5/7 14:20	146.0	4/27 16:05
NO	11.9							34.0	5/25 2:35	146.0	4/27 16:05
CO	1457.4			3272.5	5/29 15:55			3680.4	3/16 11:25	5193.4	3/16 11:55
NO_2	3.1							17.0	5/10 19:45	33.7	3/27 19:00

1 - Geometric Mean, 2 - 30-Minute Averaging Time, *Start of interval of occurrence.

TABLE II C-2 QUARTERLY SUMMARY (March '75 - May '75)
(Concentrations in micrograms per cubic meter)

TRAILER NO. 21

Recorded Parameter	Average	Maximum 24-hr. Concentration		Maximum 8-hr. Concentration		Maximum 3-hr. Concentration		Maximum 1-hr. Concentration		Maximum 5-min. Concentration	
		Value	Time	Value	Time*	Value	Time*	Value	Time*	Value	Time*
SO_2	1.0	12.1	4/26 3:00			26.1	5/5 10:10	34.3	5/5 10:50	91.2	5/5 14:25
H_2S	.3							9.0	5/9 1:30	20.8	3/19 10:40
Particulates	11.1[1]	125.0	4/25								
Total Hydro-carbons											
CH_4											
Non-CH_4 Hydrocarbons											
O_3											
NO_x											
NO											
CO											

1 - Geometric Mean, 2 - 30-Minute Averaging Time, *Start of time interval of occurrence.

TABLE II C-3 QUARTERLY SUMMARY (March '75 - May '75)
(Concentrations in micrograms per cubic meter)

TRAILER No. 22

Recorded Parameter	Average	Maximum 24-hr. Concentration		Maximum 8-hr. Concentration		Maximum 3-hr. Concentration		Maximum 1-hr. Concentration		Maximum 5-min. Concentration	
		Value	Time	Value	Time*	Value	Time*	Value	Time*	Value	Time*
SO_2	.2	13.9	5/23 10:00			17.7	5/23 20:35	18.2	5/23 20:55	169.3	3/3 9:30
H_2S	.3							14.1	3/1 10:00	84.4	3/3 9:30
Particulates	9.0[1]	82.0	4/25								
Total Hydro-carbons											
CH_4											
Non-CH_4 Hydrocarbons											
O_3											
NO_x											
NO											
CO											

1 - Geometric Mean, 2 - 30-Minute Averaging Time, *Start of time interval of occurrence.

TABLE II C-4 QUARTERLY SUMMARY (March '75 - May '75)
(Concentrations in micrograms per cubic meter)

TRAILER No. 23

Recorded Parameter	Average	Maximum 24-hr. Concentration		Maximum 8-hr. Concentration		Maximum 3-hr. Concentration		Maximum 1-hr. Concentration		Maximum 5-min. Concentration	
		Value	Time	Value	Time*	Value	Time*	Value	Time*	Value	Time*
SO_2	.3	7.2	3/29 12:00			12.0	3/29 21:05	12.2	3/29 22:05	86.0	5/4 11:05
H_2S	1.1							19.1	3/7 18:55	113.5	3/9 10:15
Particulates	15.7	171.0	3/22								
Total Hydrocarbons	872.0					1079.0	4/21 6:00			2562.6	3/24 13:15
CH_4	838.0					910.2	3/3 6:00			1189.8	4/26 19:25
Non-CH_4 Hydrocarbons	43.0					302.2	4/21 6:00			1066.1	3/17 11:50
O_3	87.9							145.9	3/8 11:40	455.2	3/8 11:50
NO_x	1.1							18.7	3/17 11:40	52.4	3/21 10:55
NO	.5							16.7	3/17 11:40	52.4	3/21 10:55
CO	572.0			940.1	3/24 12:55			2421.1	3/24 13:20	5071.5	3/24 10:55
NO_2	.6							10.1	4/28 19:40	30.0	3/20 22:15

1 - Geometric Mean, 2 - 30-Minute Averaging Time, *Start of interval of occurrence.

TABLE II C-5 QUARTERLY SUMMARY (March '75 - May '75)
(Concentrations in micrograms per cubic meter)

TRAILER No. 24

Recorded Parameter	Average	Maximum 24-hr. Concentration		Maximum 8-hr. Concentration		Maximum 3-hr. Concentration		Maximum 1-hr. Concentration		Maximum 5-min. Concentration	
		Value	Time	Value	Time*	Value	Time*	Value	Time*	Value	Time*
SO_2	.9	28.9	4/13 12:00			53.9	5/2 3:10	56.4	5/2 3:20	86.0	5/2 3:00
H_2S	.5							62.6	4/14 0:35	113.5	4/13 17:05
Particulates	8.4[1]	86.0	5/20								
Total Hydro-carbons											
CH_4											
Non-CH_4 Hydrocarbons											
O_3											
NO_x											
NO											
CO											

1 - Geometric Mean, 2 - 30-Minute Averaging Time, *Start of time interval of occurrence.

TABLE II C-6

PARTICULATE CONCENTRATION FREQUENCY DISTRIBUTION

C-b Shale Oil Monitoring Project

March 1975 - May 1975

SITE	020	021	022	023	024
Concentration $\mu g/m^3$					
260					
240-260					
220-240					
200-220					
180-200					
160-180				1	
140-160				0	
120-140		1		0	
100-120		0		0	
80-100	1	1	1	2	1
60- 80	2	2	1	1	2
40- 60	2	1	0	6	2
20- 40	7	8	3	19	8
20	76	70	74	51	74
TOTAL (No. of Samples)	88	83	79	80	87
GEOMETRIC MEAN ($\mu g/m^3$)	9.8	11.1	9.0	15.7	8.4

SO_2
Constituent

TABLE II C-7

1/2- HOUR MAXIMUM CONCENTRATIONS

By Month

Trailer	Item	Nov.(1)	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
020	Value (ug/m^3)	4.6	17.4	2.6	7.6	32.8	7.2	7.6	20.8	33.9			
	Date	11/1	12/8	1/14	2/20	3/7	4/12	5/30	6/23	7/14			
	Time (MST)	13:50	21:48	16:10	10:55	10:05	11:35	14:50	4:45	13:10			
	Wind Direction (Deg.)	204	102	134	275	190	266	292	134	157			
	Wind Speed (MPH)	5	1	5	12	8	3	7	7	1			
023	Value (ug/m^3)	0.2	97.9	50.6	5.0	12.2	8.2	7.2	3.7	13.2			
	Date	11/1	12/21	1/1	2/20	3/29	4/5	5/4	6/23	7/28			
	Time (MST)	11:15	1:55	14:30	11:30	22:05	10:05	11:00	12:45	19:15			
	Wind Direction (Deg.)	191	156	358	236	201	184	186	199	184			
	Wind Speed (MPH)	8	7	4	18	3	18	27	11	11			
021	Value (ug/m^3)	32.8	25.8	53.4	23.2	21.3	21.7	34.3	67.9	18.2			
	Date	11/1	12/19	1/26	2/21	3/25	4/25	5/5	6/16	7/11			
	Time (MST)	1:35	15:45	14:05	5:00	9:00	20:25	10:50	13:45	22:55			
	Wind Direction (Deg.)	128	324	176	156	154	288	147	304	127			
	Wind Speed (MPH)	5	7	10	5	8	11	5	15	5			
022	Value (ug/m^3)	13.0	20.8	5.9	11.7	14.1	2.6	18.2	27.4	14.5			
	Date	11/6	12/20	1/25	2/22	3/3	4/17	5/23	6/12	7/23			
	Time (MST)	17:00	1:15	14:25	8:45	8:30	3:30	20:55	0:00	0:40			
	Wind Direction (Deg.)	120	127	275	107	110	291	82	123	114			
	Wind Speed (MPH)	1	6	9	2	5	5	1	7	7			
024	Value (ug/m^3)	5.2	128.5	54.3	34.3	50.8	49.1	56.4	33.0	10.6			
	Date	11/29	12/10	1/5	2/26	3/3	4/13	5/2	6/23	7/17			
	Time (MST)	21:10	6:20	11:50	2:25	22:50	17:35	3:20	9:20	19:55			
	Wind Direction (Deg.)	80	12	178	63	60	284	103	212	170			
	Wind Speed (MPH)	3	0	9	0	3	5	0	5	8			

(1) 30-Minute Averages

TABLE II C-8

1 - HOUR MAXIMUM CONCENTRATIONS

H_2S
Constituent

By Month

Trailer	Item	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
020	Value (ug/m^3)	10.1	2.2	6.2	13.7	12.5	2.2	1.2	21.7	2.9			
	Date	11/9	12/8	1/13	2/19	3/7	4/2	5/9	6/15	7/29			
	Time (MST)	20:00	7:10	14:05	12:35	10:05	13:30	13:20	6:00	10:50			
	Wind Direction (deg.)	111	104	174	186	190	208	225	130	201			
	Wind Speed (MPH)	0	1	1	7	8	5	7	6	5			
023	Value (ug/m^3)	3.2	45.3	28.4	8.2	19.1	6.5	6.9	8.0	71.2			
	Date	11/12	12/21	1/1	2/26	3.7	4/14	5/1	6/25	7/9			
	Time (MST)	5:40	1:55	11:10	6:05	18:55	6:55	6:35	18:05	0:10			
	Wind Direction (Deg.)	123	156	315	156	165	113	238	316	57			
	Wind Speed (MPH)	4	7	4	2	7	5	1	19	3			
021	Value (ug/m^3)	58.9	4.6	4.7	9.5	7.3	4.3	9.0	13.8	3.5			
	Date	11/18	12/7	1/31	2/7	3/21	4/26	5/9	6/16	7/8			
	Time (MST)	1:25	8:00	4:35	17:10	21:30	23:20	1:30	11:40	1:40			
	Wind Direction (Deg.)	123	337	138	163	117	350	151	294	143			
	Wind Speed (MPH)	0	2	5	12	6	3	3	13	3			
022	Value (ug/m^3)	4.7	8.4	2.4	14.3	14.1	10.1	1.3	11.9	5.7			
	Date	11/18	12/8	1/25	2/28	3/1	4/11	5/28	6/15	7/14			
	Time (MST)	9:35	0:40	14:25	20:55	0:00	14:00	9:15	19:45	12:55			
	Wind Direction (Deg.)	126	69	275	72	102	34	267	57	139			
	Wind Speed (MPH)	10	8.5	9	2	5	5	8	1	4			
024	Value (ug/m^3)	8.3	7.7	27.6	8.1	8.5	62.5	56.9	70.9	3.0			
	Date	11/5	12/24	1/10	2/17	3/23	4/14	5/2	6/22	7/29			
	Time (MST)	15:55	1:55	16:45	13:10	2:40	0:35	1:40	19:05	11:55			
	Wind Direction (Deg.)	268	154	201	258	89	197	120	232	244			
	Wind Speed (MPH)	3	1	2	9	2	6	2	4	8			

O_3 Constituent

TABLE II C-9

1 - HOUR MAXIMUM CONCENTRATIONS

By Month

Trailer	Item	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
020	Value (ug/m^3)	108.1	117.9	130.9	146	146.2	115.3	124.5	160.4	130.9			
	Date	11/27	12/12	1/29	2/19	3/26	4/22	5/22	6/26	7/15			
	Time (MST)	11:50	11:45	12:00	15:55	9:00	11:50	6:40	14:00	16:45			
	Wind Direction (Deg.)	141	133	124	184	130	221	104	170	63			
	Wind Speed (MPH)	-	0	4	7	4	9	3	6	0			
023	Value (ug/m^3)	64.6	68.5	97.7	136	145.9	116.1	139.5	152.2	129.9			
	Date	11/18	12/30	1/28	2/23	3/8	4/27	5/22	6/26	7/14			
	Time (MST)	13:20	13:25	13:15	21:45	11:40	14:20	6:25	13:05	11:15			
	Wind Direction (Deg.)	209	-	269	306	197	276	197	228	325			
	Wind Speed (MPH)	20	2	12	3	15	9	3	10	5			
021	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
022	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
024	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												

NO
Constituent

TABLE II C-10

1 - HOUR MAXIMUM CONCENTRATIONS

By Month

Trailer	Item	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
020	Value (ug/m^3)	44.3	16.4	43.7	7.8	4.7	27.1	34.0	29.8	3.1			
	Date	11/10	12/9	1/22	2/19	3/19	4/26	5/25	6/1	7/31			
	Time (MST)	5:50	7:05	7:30	9:35	19:15	14:30	2:35	8:55	22:20			
	Wind Direction (Deg.)	131	106	105	126	122	235	9	294	129			
	Wind Speed (MPH)	0	2	1	8	4	11	3	3	4			
023	Value (ug/m^3)	38.5	93.9	114.2	52.6	16.7	10.1	4.2	28.7	15.3			
	Date	11/28	12/24	1/17	2/9	3/17	4/27	5/8	6/28	7/13			
	Time (MST)	8:10	1:05	9:55	9:25	11:40	7:25	11:40	3:25	4:30			
	Wind Direction (Deg.)	303	263	116	179	9	328	295	240	83			
	Wind Speed (MPH)	11	4	3	11	10	11	10	5	4			
021	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
022	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
024	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												

TABLE II C-11

1 - HOUR MAXIMUM CONCENTRATIONS

NO_2

Constituent

By Month

Trailer	Item	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
020	Value (ug/m^3)	26.7	36.0	17.6	14.4	11.2	16.7	17.0	20.8	33.9			
	Date	11/26	12/3	1/25	2/1	3/19	4/18	5/10	6/23	7/14			
	Time (MST)	22:30	17:10	6:35	0:45	18:40	16:20	19:45	4:45	13:10			
	Wind Direction (Deg.)	95	120	106	107	137	277	127	134	157			
	Wind Speed (MPH)	3	0	4	2	5	11	4	7	1			
023	Value (ug/m^3)	21.2	47.0	68.2	9.2	4.8	10.1	8.0	3.7	13.2			
	Date	11/26	12/6	1/16	2/23	3/23	4/28	5/1	6/23	7/28			
	Time (MST)	16:00	13:10	9:15	20:10	7:10	19:40	8:35	12:45	19:15			
	Wind Direction (@30')	315	57	143	179	146	60	95	199	184			
	Wind Speed (@ 30')	7	5	4	4	4	6	5	11	11			
021	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
022	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
024	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												

Table II C-12

Non-Methane HC
Constituent

3 - HOUR MAXIMUM CONCENTRATIONS
(6-9 am)

By Month

Trailer	Item	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
020	Value (ug/m^3)	197.6	179.7	223.8	51.4	288.6 (2)	707.7 (2)	83.5	141.2	69.6			
	Date	11/25	12/19	1/12	2/25	3/31	4/22		6/21	7/7			
	Time (MST)												
	Wind Direction (Deg.)	127	101	117	107	128	130	172	68	93			
	Wind Speed (MPH)	11	1	7	4	3	6	3	2	0			
023	Value (ug/m^3)	17151.9 (1)	33269.7 (1)	2316 (1)	18.1	34.2	302.2	120.0	355.1 (2)	895.6 (2)			
	Date	11/23	12/12	1/4	2/28	3/31	4/21	5/26	6/5	7/9			
	Time (MST)												
	Wind Direction (Deg.)	28	179	116	182	194	139?	281	22,	131			
	Wind Speed (MPH)	3	6	6	7	15	1	3	2	5			
021	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
022	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
024	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												

(1) Reported data are incorrect because of contaminated manifold.
(2) Reported data may be incorrect because of malfunctioning instrument.

Methane HC
Constituent

TABLE II C-13

3 - HOUR MAXIMUM CONCENTRATIONS
(6-9 a.m.)

1974 By Month

Trailer	Item	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
020	Value (ug/m^3)	933.2	1219.5	999.2	1298.0	998.9	837.8 (2)	924.0	862.5	859.2			
	Date	11/9	12/8	1/12	2/3	3/15	4/28	5/2	6/2	7/31			
	Time (MST)												
	Wind Direction (Deg.)	77	111	118	278	~317	124	172	125	334			
	Wind Speed (MPH)	0	2	6	3	-	1	3	6	0			
023	Value (ug/m^3)	96.7 (1)	1925.3 (1)	1137.7 (1)	900.1	910.2	902.4	903.9	879.1	879.4			
	Date	11/7	12/29	1/1	2/15	3/3	4/18	5/2	6/6	7/29			
	Time (MST)												
	Wind Direction (@ 30')	98	151	144	306	159	228	180	65	179			
	Wind Speed (@ 30')	4	3	4	9	0	9	2	4	8			
021	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
022	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
024	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												

(1) Report data are incorrect because of contaminated manifold.
(2) Reported data may be incorrect because of malfunctioning instrument.

Table II C-14

CO
Constituent

1 - HOUR MAXIMUM CONCENTRATIONS

By Month

1974

Trailer	Item	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
020	Value (ug/m³)	1353.8	1853.7	1700.8	1716.6 (2)	3680.4 (2)	1811.5 (2)	3296.9 (2)	4650.9 (2)	2065.3 (2)			
	Date	11/14	12/15	1/11	2/19	3/16	4/11	5/29	6/4	7/29			
	Time (MST)	11:55	13:30	19:30	10:05	11:25	13:35	18:20	4:55	14:55			
	Wind Direction (Deg.)	113	117	341	115	147	360	126	108	219			
	Wind Speed (MPH)	0	1	6	5	12	5	6	1	5			
023	Value (ug/m³)	14563.1 (1)	5061.4 (1)	2563.2 (1)	769.7	2421.1	740.9	1155.9	790.8	1635.9			
	Date	11/14	12/19	1/23	2/3	3/24	4/26	5/27	6/26	7/9			
	Time (MST)	15:25	4:50	17:15	15:05	13:20	7:20	17:15	22:10	11:50			
	Wind Direction (Deg.)	210	246	214	202	206	39	96	114	175			
	Wind Speed (MPH)	11	10	7	10	12	5	13	5	3			
021	Value (ug/m³)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
022	Value (ug/m³)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
024	Value (ug/m³)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												

(1) Reported data are incorrect because of contaminated manifold.
(2) Reported data may be incorrect because of malfunctioning instrument.

Methane HC
Constituent

TABLE II C-13

3 - HOUR MAXIMUM CONCENTRATIONS
(6-9 a.m.)

1974 By Month

Trailer	Item	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
020	Value (ug/m^3)	933.2	1219.5	999.2	1298.0	998.9	(2) 837.8	924.0	862.5	859.2			
	Date	11/9	12/8	1/12	2/3	3/15	4/28	5/2	6/2	7/31			
	Time (MST)												
	Wind Direction (Deg.)	77	111	118	278	~317	124	172	125	334			
	Wind Speed (MPH)	0	2	6	3	-	1	3	6	0			
023	Value (ug/m^3)	(1) 96.7	(1) 1925.3	(1) 1137.7	900.1	910.2	902.4	903.9	879.1	879.4			
	Date	11/7	12/29	1/1	2/15	3/3	4/18	5/2	6/6	7/29			
	Time (MST)												
	Wind Direction (@ 30')	98	151	144	306	159	228	180	65	179			
	Wind Speed (@ 30')	4	3	4	9	0	9	2	4	8			
021	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
022	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
024	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												

(1) Report data are incorrect because of contaminated manifold.
(2) Reported data may be incorrect because of malfunctioning instrument.

Table II C-14

CO
Constituent

1 - HOUR MAXIMUM CONCENTRATIONS

By Month

1974

Trailer	Item	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
020	Value (ug/m^3)	1353.8	1853.7	1700.8	1716.6 (2)	3680.4 (2)	1811.5 (2)	3296.9 (2)	4650.9 (2)	2065.3 (2)			
	Date	11/14	12/15	1/11	2/19	3/16	4/11	5/29	6/4	7/29			
	Time (MST)	11:55	13:30	19:30	10:05	11:25	13:35	18:20	4:55	14:55			
	Wind Direction (Deg.)	113	117	341	115	147	360	126	108	219			
	Wind Speed (MPH)	0	1	6	5	12	5	6	1	5			
023	Value (ug/m^3)	14563.1 (1)	5061.4 (1)	2563.2 (1)	769.7	2421.1	740.9	1155.9	790.8	1635.9			
	Date	11/14	12/19	1/23	2/3	3/24	4/26	5/27	6/26	7/9			
	Time (MST)	15:25	4:50	17:15	15:05	13:20	7:20	17:15	22:10	11:50			
	Wind Direction (Deg.)	210	246	214	202	206	39	96	114	175			
	Wind Speed (MPH)	11	10	7	10	12	5	13	5	3			
021	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
022	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
024	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												

(1) Reported data are incorrect because of contaminated manifold.
(2) Reported data may be incorrect because of malfunctioning instrument.

Particulate Constituent

TABLE II C-15

24 - HOUR MAXIMUM CONCENTRATIONS

Midnight - Midnight

By Month

Trailer	Item	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
020	Value (ug/m^3)	133.0	11.0	17.0	11.0	39.0	89.0	70.0	48.0	47.0			
	Date	11/29	12/12	1/18	2/27	3/22	4/25	5/20	6/18	7/12			
	(1)24-hr. ave. Wind Direction (Deg)	121	107	117	124	195	170	236	119	60			
	Max. 1-hr. ave. Wind Speed (MPH)	5	8	8	5	14	24	20	12	6			
	Wind Speed - 24-hr. ave. (MPH)	2	3	5	4	7	15	10	6	4			
023	Value (ug/m^3)	26.0	22.0	6.0	11.0	171.0	112.0	107.0	65.0	42.0			
	Date	11/27	12/4	1/11	2/27	3/22	4/25	5/20	6/17	7/1			
	(1)24-hr. ave. Wind Direction	174	171	313	192	226	186	234	215	188			
	Max. 1-hr. ave. Wind Speed	15	18	16	5	38	41	34	23	18			
	Wind Speed - 24-hr. ave.	7	10	8	4	16	27	17	11	9			
021	Value (ug/m^3)	71.0	18.0	7.0	10.0	32.0	125.0	97.0	75.0	28.0			
	Date	11/21	12/10	1/13	2/28	3/22	4/25	5/20	6/19	7/7			
	(1)24-hr. ave. Wind Direction	114	102	4	140	170	168	327	143	56			
	Max. 1-hr. ave. Wind Speed	10	9	6	8	20	28	21	14	9			
	Wind Speed - 24-hr. ave.	4	4	3	4	9	14	12	9	4			
022	Value (ug/m^3)	154.0	116.0	10.0	12.0	44.0	82.0	80.0	55.0	69.0			
	Date	11/28	12/1	1/26	2/12	3/21	4/25	5/20	6.18	7/24			
	(1)24-hr. ave. Wind Direction	290	137	112	116	168	136	183	121	354			
	Max. 1-hr. ave. Wind Speed	9	9?	12	12	9	16	15	8	11			
	Wind Speed - 24-hr. ave.	5	5	5	7	5	13	9	5	7			
024	Value (ug/m^3)	178.0	8.0	16.0	9.0	27.0	80.0	86.0	52.0	27.0			
	Date	11/27	12/5	1/27	2/28	3/22	4/25	5/20	6/18	7/2			
	(1)24-hr. ave. Wind Direction	118	261	248	130	196	180	235	205	141			
	Max. 1-hr. ave. Wind Speed	8	7	5	8	33	37	30	18	21			
	Wind Speed - 24-hr. ave.	4	2	3	4	13	22	14	9	6			

(1) Vector Averages

* 50% Or Less Data
(1) Reported data are incorrect because of contaminated manifold.
(2) Reported data may be incorrect because of malfunctioning instrument.

TABLE II C- 16

MONTHLY AVERAGE CONCENTRATIONS

1974-1975

Trailer	Item	Month											
		Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct
020	NO(ug/m3)	1.9	0.7	3.4	*0.4	*0.3	9.6	17.8	*3.2	*0.4			
023		4.4	*12.8	14.7	0.4	*1.2	0.6	0.1	0.3	0.6			
020	NO_2(ug/m3)	2.8	6.8	4.5	*2.5	*1.2	2.7	4.1	*0.3	*1.7			
023		2.4	*4.7	7.4	0.2	*0.4	0.9	0.5	0.0	1.5			
020	O_3(ug/m3)	58.0	69.3	93.7	105.1	88.0	77.1	71.5	69.1	74.6			
023		*31.4	28.0	42.4	85.8	85.6	90.5	87.3	84.4	86.1			
020	Non-Methane H.C. (ug/m3)	73.4	97.4	*75.7	23.4	38.6	327.6(2)	38.9	50.8	25.8			
023		933.0(1)	20213.6(1)	*662.8(1)	22.1	*17.1	49.1	43.3	196.5	220.2			
020	CH_4(ug/m3)	826.1	918.8	*908.1	879.4	829.8	590.6(2)	833.6	821.2	825.9			
023		149.7(1)	1053.8(1)	*943.6(1)	*833.7	*859.8	836.3	834.3	814.7	780.7			
020	CO(ug/m3)	553.8	676.9	908.2	1228.5(2)	1498.0(2)	*853.0(2)	1815.5(2)	1092.1(2)	206.5(2)			
023		3703.6(1)	2439.3(1)	1786.2(1)	391.4	504.5	485.8	699.9	437.0	468.5			
020	SO_2(ug/m3)	0	1.8	0	0.1	1.1	0.1	0	1.0	1.6			
021		1.3	1.7	0.8	0.8	0.6	1.2	1.1	2.1	1.3			
022		2.6	0.1	0	0.2	0	0	0.5	1.7	0.4			
023		0	6.4	3.3	0.1	0.6	0.5	0	0.0	0.6			
024		0.2	1.7	1.3	5.5	0.9	1.1	0.7	0.6	0.1			
020	H_2S(ug/m3)	0	0	0	0	0.4	0	0	0.2	0			
021		1.6	0	0.2	0.8	0.4	0.2	0.4	0.7	0.2			
022		0.2	1.2	0	0.2	0.3	0.7	0	0.4	0.2			
023		0	5.2	2.5	0.7	2.7	0.5	0.3	0.3	4.8			
024		0	0.1	0	0.2	0.4	1.0	0.3	1.1	0.1			
020	Particulate(ug/m3)	*48.7	4.3	3.3	3.8	6.5	11.6	12.4	10.7	14.7			
021		*20.4	5.4	4.0	4.5	6.9	13.7	13.2	12.3	15.6			
022		*35.3	4.2	2.9	3.2	5.3	11.9	11.2	9.5	14.6			
023		*18.0	*6.8	*2.5	4.2	11.5	15.4	19.3	18.3	14.4			
024		*117.0	2.9	2.3	3.8	4.9	10.2	11.4	8.7	11.3			

The July one-hour maximum concentration for H_2S at Trailer 023 is the highest value yet to be reported for this gas and represents a very large increase from the May and June values. On the other hand, both the July one-hour maximums and the monthly averages for H_2S for the remaining four Trailers show a decrease in the ambient air concentrations.

The correlations of wind direction with ambient air concentrations for the different gases are displayed in a bi-variate frequency distribution in the Radian monthly data reports. A month-to-month examination of these data for H_2S or SO_2 has failed to establish any consistent or predictable long-term patterns.

The significance of the reported H_2S and SO_2 data and the interpretation of the observations made in these reports are not obvious. As has been stated in previous reports, these observed trends and patterns in the concentration of these two gases have not provided an explanation as to the possible source, type, or location. However, these data confirm that high concentrations are not isolated events and occur frequently.

In addition to the normal instrument monitoring for sulfur dioxide, analyses were performed in July for this gas using both the West-Gaeke wet chemical measurement and a modified version of this method using an impregnated filter in place of the usual gas bubbler (method to be published by H. A. Axelrod, Anal. Chem.). The July 4-5 sulfur dioxide levels were below the estimated 0.5 ppb detection limit for the standard West-Gaeke bubbler technique. However, six simultaneous samples, collected at Trailer 023, on July 25, using the impregnated filters, yielded an average sulfur dioxide level of 0.13 ppb. The sulfur dioxide and hydrogen sulfide detection instruments in Trailer 023 were reading zero at this same time since this value (0.13) is below the minimum detectable limits of the instruments in the Trailer.

Ozone is measured only at Trailers 020 and 023. The ozone (O_3) monthly one-hour maximums are given in Table II C-9 and the monthly averages are given in Table II C-16. The plateau concentrations at Trailer 023 continue near the higher monthly averages which began last February, and are slightly above those measured in the valley at Trailer 020. The higher ozone levels on the plateau reported since April contrast with the higher ozone levels in the valley during the winter months. The June monthly one-hour maximums are the highest ozone concentrations reported to date for both the valley and the plateau.

As was noted in the last two summary reports, there appears to be a very obvious diurnal ozone trend at both Trailers. The May through July diurnal ozone variations are surprisingly similar and indicate a minimum ozone concentration at 0600 which begins to increase at 0700. It reaches a peak around 1300 and decreases to a low around 2300 hours at the valley Trailer 020. The Trailer 023 on the plateau indicates a very similar trend except that the minimum and peak onset appear one hour later than in the valley. The similarity in the diurnal trends

between the two Trailers is remarkable and a review of the complete diurnal tables shows a correlation between the two that coincides even to the hour on certain days. This high degree of correlation would seem to suggest that both Trailers are measuring the same air mass with respect to the ozone levels. It seems unlikely that the maximum ozone levels which are significantly above the accepted background level of 80 ug/m^3 could be the result of downwind urban pollution. It seems equally unlikely that stratospheric transport of ozone would produce the consistent diurnal trends or could cause the valley concentrations during the winter months to exceed those of the plateau.

The monthly one-hour maximums for nitric oxide (NO) and nitrogen dioxide (NO_2) are reported in Tables II C-10 and II C-11, respectively. The monthly averages are presented in Table II C-16. Only partial-days data for Trailer 020 are reported during June and July because of instrument malfunction. The February-through-July monthly averages for these two gases reported for Trailer 023 are generally lower than the same values for the preceeding months. These lower values may be because of decreased activities associated with the Tract corehole drilling operations or the greater instability of the atmosphere during the spring and summer months which would enhance the dispersion of these pollutants, or both.

The data through May reported for Trailer 020 show an increasing trend of both NO and NO_2 and may be associated with the increased automobile traffic along the Piceance Creek road in the valley. Unusual, sudden shifts in the values of the reported data which persist over a period of several days have been investigated in detail in order to substantiate data validity.

The 6:00 - 9:00 a.m. maximums for the non-methane hydrocarbons (NMHC) are given in Table II C-12 and in Table II C-13 for methane. The monthly averages are given in Table II C-16. The footnote for the November, December, and January data at Trailer 023 has already been explained in the Summary Report #3. The other footnote refers to the April data at Trailer 020 which may be in error due to a faulty instrument.

The 6:00 - 9:00 a.m. maximum and the monthly averages for the May through July methane concentrations are quite similar. There are no differences between the values at valley Trailer 020 and the plateau Trailer 023. The methane concentration measured in the Tract vicinity is in agreement with the accepted background range of 814 - 977 ug/m^3 at 760 mm and 0^oC.

The non-methane hydrocarbon (NMHC) 6:00 - 9:00 a.m. maxima and average monthly concentrations show much greater variation and significant difference between the valley and plateau sites. Considerable caution is urged in interpreting these data. Recent tests conducted by Environmental Protection Agency have indicated that the precision of the NMHC measurements determined by subtractive gas chromatograph (the

method most frequently employed and used in C-b's air quality network) is poor. Bearing this in mind the rather large increase in the monthly average for Trailer 023 during May through June could be significant. It was mentioned in the Summary Report #3 that this could be associated with warmer temperatures of the season and the increased vegetation growth which would promote the release of volatile vegetation-related organics into the atmosphere. However, additional data are necessary to establish whether or not this is a real trend. Increased automobile traffic could produce a similar trend.

Tables II C-14 and II C-16 give the one-hour maxima and the monthly averages, respectively, for carbon monoxide. Again, the footnotes indicate data that are incorrect owing to the contaminated manifold at Trailer 023 or data suspected of being in error because of a possible malfunction in the instrument. The contaminated manifold and its probable effect on the carbon monoxide data were discussed in the Summary Report #3. Daily carbon monoxide data for Trailer 020 for the period from February into April show an unexplained gradual upward trend that exceeds by several times both the earlier concentrations measured at this site and the carbon monoxide concentration measured by Trailer 023. This trend is interrupted suddenly on April 27, after the analytical and stripper columns were replaced in the monitoring instrument. Following this change, the carbon monoxide levels show a significant decrease and are similar to those concentrations reported for Trailer 023. On May 6th, a faulty heating control destroyed the oven and catalytic converter for the carbon-monoxide-to-methane conversion. The columns and catalyst were then replaced. Following this the carbon monoxide measurements suddenly indicated a sixfold increase. These high readings continued until June 7th when a sudden decrease was observed. A similar decrease was again observed on June 21st. These decreases have persisted and the low carbon monoxide levels continued into July, representing only a fraction of the measured values at Trailer 023.

The carbon monoxide data do not indicate any significant changes in level from May through July. The carbon monoxide levels in the Tract vicinity may be influenced by automobile traffic.

The particulate 24-hour maxima and the monthly averages are reported in Tables II C-15 and II C-16, respectively. These data seem to indicate a seasonal trend with higher particulate concentrations occurring in the spring and summer months and the lower concentrations in the winter months. Such a trend would be expected with the disappearance of the winter snow cover and the generally drier soil conditions and higher wind speeds during the warmer months.

The May 24-hour maxima correlate well with the monthly one-hour maximum high wind speeds reported in Table II C-20. The June and July 24-hour maxima do not show a similar correlation. It may be that the agricultural activities in the Piceance Creek Valley near the Tract play a more important role than does the wind in its contribution to the ambient air particulate concentration. Certainly, the particulate

concentrations measured at the valley Trailers 020, 021, and 022 were affected by the alfalfa plantings and harvests during these months. During these two months heavy-duty grading equipment was used in the immediate vicinity of Trailer 022 on several occasions, undoubtedly contributing further to the particulate concentrations at this site.

Special cellulose filters which have a low trace-element background are used to collect particulates every sixth day at Trailer 023. These filters are screened for trace elements and radioactivity and analyzed as a quarterly composite in order to determine average concentrations, (Table II C-17). A spot-check, single-filter sample has been analyzed to detect any gross short-term variations from the average (Table II C-18). Table II C-19 reports the gross alpha and gross beta radioactivity in picocuries per cubic meter (pCi/m^3) for both the composite and single particulate sample. The first report of these data for the months of November and December was included as part of the first Radian quarterly data report for September - November. The second set of these data for the months of January, February and March, as well as a correction thereto and the concentrations in ug/m^3 and pCi/m^3 for the first quarter are included in the Quarterly Data Report #4. The concentrations for these elements as well as the gross beta radioactivity remain well below the hazardous levels. These measured radioactivity levels are well below the 1 pCi/m^3 level which is stipulated in the Conditions of Approval as the level below which further quantitative analyses is not required and can be considered to be normal background radiation.

Also reported for the 4th quarter are the volatile trace metals, selenium, mercury, and arsenic (or arsine), collected once per quarter at Trailer 023. These values for the July 25th sampling are: 0.0027 ug/m^3 mercury, 0.16 ug/m^3 selenium, and 7.83 ug/m^3 arsine.

Particulate size distributions at Trailer 023 are also determined once per quarter; for this quarter, they are:

Size Range in Microns	Concentration in ug/m^3
7.0 - Above	5.02
3.3 - 7.0	3.43
2.0 - 3.3	2.64
1.1 - 2.0	1.85
0.01- 1.1	1.58

Regarding near-surface meteorology, Tables II C-20 and II C-21 present a meteorological summary of winds, temperature, precipitation, and relative humidity by Trailer for each month to date, with the months of May through July representing new data.

Maximum hourly temperature achieved to date on the plateau of the Tract was 90°F, occurring in July; maximum in Piceance Creek Valley was also 90°F (July). Minima to date have been -29°F (January) and -51°F (January) on Tract and in Piceance Creek Valley respectively. Relative

TABLE II C-17
AMBIENT CONCENTRATIONS OF TRACE ELEMENTS ON TRACT C-b
Composite Samples
Concentrations in ug/m^3

	Composite Nov.-Dec. 1974	Composite Jan. - March 1975	Composite April-June 1975	Composite
Uranium	$7x10^{-5}$	$2x10^{-3}$	$2x10^{-4}$	
Thorium	$6x10^{-5}$		$3x10^{-4}$	
Bismuth	$2x10^{-5}$	$1x10^{-4}$	$2x10^{-4}$	
Lead	$3x10^{-3}$	$2x10^{-3}$	$5.8x10^{-3}$	
Thallium				
Mercury	$2x10^{-5}$	$2x10^{-8}$	$2x10^{-4}$	
Gold				
Platinum				
Iridium				
Osmium				
Rhenium		Internal Standard	Internal Standard	
Tungsten	$4x10^{-5}$		*	
Tantalum				
Hafnium				
Lutecium				
Ytterbium				
Thullium				
Erbium				
Holmium				
Dysprosium				

	Composite Nov.-Dec. 1974	Composite Jan. - March 1975	Composite April-June 1975	Composite
Terbium				
Gadolinium			$1x10^{-5}$	
Europium			$2x10^{-5}$	
Samarium			$2x10^{-4}$	
Neodymium	$4x10^{-4}$	$1x10^{-4}$	$5x10^{-4}$	
Praseodymium	$3x10^{-5}$	$2x10^{-5}$	$2x10^{-4}$	
Cerium	$1x10^{-4}$	$1x10^{-4}$	$4x10^{-3}$	
Lanthanum	9x10-5	$5x10^{-5}$	$1x10^{-3}$	
Barium	$1x10^{-3}$	$1x10^{-3}$	$2.9x10^{-2}$	
Cesium	$7x10^{-5}$		$1x10^{-4}$	
Iodine			$8x10^{-5}$	
Tellurium				
Antimony	$5x10^{-5}$	$8x10^{-5}$	$8x10^{-5}$	
Tin	$6x10^{-4}$	$2x10^{-4}$	$2x10^{-4}$	
Indium		Internal Standard	Internal Standard	
Cadmium			$2x10^{-4}$	
Silver	$6x10^{-4}$	$2x10^{-5}$	$2x10^{-5}$	
Palladium				
Rhodium				
Radium	10^{-15}	10^{-15}	10^{-14}	

	Composite Nov.-Dec. 1974	Composite Jan.-March 1975	Composite April-June 1975	Composite
Ruthenium				
Molybdenum	$2x10^{-4}$		*	
Niobium	$6x10^{-5}$		$2x10^{-3}$	
Zirconium	$3x10^{-4}$		$3.8x10^{-3}$	
Yttrium	$1x10^{-4}$	$1x10^{-4}$	$5x10^{-4}$	
Strontium	$3x10^{-3}$	$2x10^{-4}$	$1.2x10^{-2}$	
Rubidium	$2x10^{-3}$	$9x10^{-4}$	$5x10^{-4}$	
Bromine		$1x10^{-4}$	$2x10^{-5}$	
Selenium	$8x10^{-7}$	$6x10^{-5}$	$4x10^{-5}$	
Arsenic	$1x10^{-4}$	$1x10^{-3}$	$3x10^{-4}$	
Germanium	$3x10^{-5}$	$3x10^{-5}$	$4x10^{-5}$	
Gallium	$1x10^{-4}$	$1x10^{-5}$	$1x10^{-4}$	
Zinc	$1x10^{-2}$	$9x10^{-3}$	*	
Copper	$9x10^{-3}$	$6x10^{-2}$	$1.3x10^{-2}$	
Nickel	$4x10^{-4}$	$3x10^{-4}$	*	
Cobalt	$3x10^{-4}$		$3x10^{-4}$	
Iron	$3x10^{-2}$	2.6	0.81	
Manganese	$3x10^{-3}$	$7x10^{-2}$	$8.1x10^{-3}$	
Chromium	$7x10^{-4}$		$4.3x10^{-3}$	

	Composite Nov.-Dec. 1974	Composite Jan.-March 1975	Composite April-June 1975	Composite
Vanadium	$4x10^{-4}$	$2x10^{-4}$	$9x10^{-4}$	
Titanium	$4x10^{-3}$	$6x10^{-3}$	$9.6x10^{-2}$	
Scandium			$2x10^{-4}$	
Calcium	.3	.44	1.2	
Potassium	.1	.26	0.20	
Chlorine	$1x10^{-3}$		*	
Sulphur	$7x10^{-3}$	$6x10^{-2}$	$8.5x10^{-2}$	
Phosphorus	$3x10^{-3}$	$4.2x10^{-2}$	$6.5x10^{-2}$	
Silicon		.42	1.2	
Aluminum	.1	$2x10^{-2}$	0.31	
Magnesium	.2	3.6	0.13	
Sodium	$5x10^{-2}$	4.2	0.14	
Fluorine	$1x10^{-2}$		*	
Oxygen		NR	NR	
Nitrogen		NR	NR	
Carbon		NR	NR	
Boron	$2x10^{-2}$		NR	
Beryllium	$2x10^{-7}$		$3x10^{-5}$	
Lithium	$1x10^{-4}$		$3.1x10^{-3}$	

NOTE: NR--Not reported
When no number appears, concentration is less than $1x10^{-5}$ ug/m^3

*Unable to determine because of blank level.

TABLE II C-18
TRACE ELEMENT ANALYSIS
OF SINGLE FILTER SAMPLES ON TRACT C-b
Concentrations in ug/m^3

	Single Filter Sample 12/4/74	Single Filter 1/28/75	Single Filter 4/24/75	Single Filter
Uranium	$5x10^{-5}$		$1x10^{-4}$	
Thorium	$3x10^{-5}$		$2x10^{-4}$	
Bismuth	$3x10^{-5}$	$1x10^{-3}$	$2x10^{-4}$	
Lead	$1x10^{-2}$		$1.2x10^{-2}$	
Thallium				
Mercury	$1x10^{-5}$	$2x10^{-8}$	$2x10^{-4}$	
Gold				
Platinum				
Iridium				
Osmium				
Rhenium	Internal Standard		Internal Standard	
Tungsten	$3x10^{-5}$		$2x10^{-6}$	
Tantalum				
Hafnium				
Lutecium				
Ytterbium				
Thullium				
Erbium				
Holmium				
Dysprosium				

	Single Filter Sample 12/4/74	Single Filter 1/28/75	Single Filter 4/24/75	Single Filter
Terbium				
Gadolinium				
Europium				
Samarium				
Neodymium	$9x10^{-5}$		$1x10^{-4}$	
Praseodymium	$7x10^{-5}$		$2x10^{-4}$	
Cerium	$5x10^{-4}$	$1x10^{-4}$	$1.5x10^{-3}$	
Lanthanum	$2x10^{-4}$	$1x10^{-4}$	$1.7x10^{-3}$	
Barium	$2x10^{-3}$	$2x10^{-3}$	$1.5x10^{-2}$	
Cesium	$1x10^{-4}$			
Iodine		$8x10^{-4}$	$7x10^{-5}$	
Tellurium	$4x10^{-5}$			
Antimony	$2x10^{-4}$	$5x10^{-5}$	$1x10^{-4}$	
Tin	$2x10^{-3}$	$2x10^{-4}$	$2x10^{-4}$	
Indium		Internal Standard	Internal Standard	
Cadmium	$8x10^{-7}$	$2x10^{-4}$	$1x10^{-4}$	
Silver	$1x10^{-4}$		$2x10^{-5}$	
Palladium				
Rhodium				
Radium	$<10^{-15}$	$<10^{-15}$	$<10^{-15}$	

	Single Filter Sample 12/4/74	Single Filter 1/28/75	Single Filter 4/24/75	Single Filter
Ruthenium				
Molybdenum	$5x10^{-4}$	$1x10^{-3}$	*	
Niobium	$7x10^{-5}$	$2x10^{-5}$	$1.2x10^{-3}$	
Zirconium	$1x10^{-3}$	$1x10^{-5}$	$3.1x10^{-3}$	
Yttrium	$2x10^{-4}$	$2x10^{-4}$	$4x10^{-4}$	
Strontium	$6x10^{-3}$	$5x10^{-3}$	$1.3x10^{-2}$	
Rubidium	$4x10^{-3}$	$2x10^{-4}$	$6x10^{-4}$	
Bromine	$7x10^{-5}$	$7x10^{-4}$	$4x10^{-4}$	
Selenium	$8x10^{-5}$	$1x10^{-4}$	$4x10^{-4}$	
Arsenic	$7x10^{-4}$	$2x10^{-3}$	$3x10^{-4}$	
Germanium		$2x10^{-5}$	$4x10^{-5}$	
Gallium	$5x10^{-4}$	$2x10^{-5}$	$1x10^{-4}$	
Zinc	$2x10^{-2}$	$3x10^{-3}$	*	
Copper	$2x10^{-2}$	$2x10^{-3}$	$3.1x10^{-3}$	
Nickel	$3x10^{-4}$	$4x10^{-4}$	$2x10^{-4}$	
Cobalt	$4x10^{-4}$		$2x10^{-4}$	
Iron	$7x10^{-2}$	1.6	≈ 0.81	
Manganese	$1x10^{-2}$	$5x10^{-2}$	$1.1x10^{-2}$	
Chromium	$1x10^{-3}$		$6x10^{-4}$	

	Single Filter Sample 12/4/74	Single Filter 1/28/75	Single Filter 4/24/74	Single Filter
Vanadium	$2x10^{-3}$	$5x10^{-4}$	$2.1x10^{-3}$	
Titanium	$9x10^{-3}$	$1.4x10^{-2}$	0.11	
Scandium			$1x10^{-4}$	
Calcium	1.1	.5	≈ 1.7	
Potassium	0.7	.42	0.35	
Chlorine	$3x10^{-3}$		$2.4x10^{-3}$	
Sulphur	$7x10^{-2}$	$1.8x10^{-2}$	0.24	
Phosphorus	$5x10^{-3}$	2.1	0.14	
Silicon		1.8	≈ 2.1	
Aluminum	.2	.12	≈ 0.48	
Magnesium	0.47	3.9	0.18	
Sodium	$6x10^{-2}$		0.11	
Fluorine	$4x10^{-3}$	.25	0.016	
Oxygen		NR	NR	
Nitrogen		NR	NR	
Carbon		NR	NR	
Boron	$8x10^{-3}$	$9x10^{-3}$	NR	
Beryllium	$2x10^{-6}$			
Lithium	$3x10^{-4}$		$2.4x10^{-3}$	

NOTE: NR--Not Reported
When no numbers appear, concentration is less than $1x10^{-5}$ ug/m^3

* Unable to determine because of blank level.

TABLE II C-19

Gross Radioactivity (pCi/m^3)

Date of Sample Collection	Gross Alpha ± Precision (1)	Gross Beta ± Precision (1)
Composite of Samples November - December	$6.5 \times 10^{-4} \pm 2.7 \times 10^{-4}$ (3)	$11.4 \times 10^{-2} \pm 0.4 \times 10^{-2}$ (2)
Single Day Sample 12/4/74	$13.0 \times 10^{-4} \pm 8.0 \times 10^{-4}$	$13.2 \times 10^{-2} \pm 0.8 \times 10^{-2}$
Composite of Samples January - March	$6.3 \times 10^{-4} \pm 4.1 \times 10^{-4}$ (4)	$7.1 \times 10^{-2} \pm 0.1 \times 10^{-2}$ (2)
Single Day Sample 1/28/75	$3.4 \times 10^{-4} \pm 1.3 \times 10^{-4}$	$19.6 \times 10^{-2} \pm 4.2 \times 10^{-2}$
Composite of Samples April - June	$6.3 \times 10^{-4} \pm 1.1 \times 10^{-4}$	$3.1 \times 10^{-2} \pm 0.09 \times 10^{-2}$
Single Day Sample 4/24/75	$19.0 \times 10^{-4} \pm 6.0 \times 10^{-4}$	$5.0 \times 10^{-2} \pm 0.4 \times 10^{-2}$
Composite of Samples		
Single Day Sample		

(1) Variability of radioactivity disintegration process (counting error) at the 95% confidence level, 1.96 α

(2) Blank Gross Beta 0.004 ± 0.004 pCi/cm^2 (420 cm^2/ filter)

(3) Blank Gross Alpha 0.0004 ± 0.0004 pCi/cm^2 (420 cm^2/filter)

(4) Blank Gross Alpha 0.0007 ± 0.0006 pCi/cm^2 (420 cm^2/filter)

TABLE II C-20
METEOROLOGICAL SUMMARY:
WINDS AND TEMPERATURE
1974-1975

Trailer	Item	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.
020	Temperature, Hourly Max. (°F)	50	45	50	47	59	69	78	87	89			
021		52	46	53	49	57	68	78	88	90			
022		53	47	53	47	55	68	77	78	87			
023		48	49	43	42	50	68	71	83	84			
024		--	37	51	47	55	62	77	87	90			
020	Temperature, Hourly Min. (°F)	-14	-30	-46	-24	-28	-19	15	30	42			
021		-17	-34	-51	-29	-28	-21	16	25	37			
022		0	-22	-38	-22	-23	-15	14	31	45			
023		5	0	-5	0	-6	6	22	34	51			
024		--	-8	-29	-10	-18	-5	28	32	51			
020	Temperature, Hourly Ave. (°F)	27	13	15	19	32	36	48	58	67			
021		27	11	15	20	30	35	47	56	67			
022		29	15	18	21	30	36	48	56	68			
023		32	25	23	24	31	35	46	56	67			
024		--	15	22	24	32	38	49	61	71			
Tower, 200'	Wind Speed, 5-Min. Max. (MPH)	39	52	48	36	52	56	53	52	42			
020	Wind Speed, Hourly Max. (MPH)	11	11	18	18	17	24	20	16	19			
021		19	13	19	17	20	28	21	20	16			
022		15	20	18	17	19	17	15	17	15			
023		25	38	32	24	38	43	38	28	25			
024		19	25	25	20	33	37	31	25	21			
020	Wind Speed, Hourly Ave. (MPH)	3	3	5	5	5	6	6	6	4			
021		3	4	6	6	6	6	6	6	4			
022		5	5	6	6	6	6	6	6	5			
023		7	7	8	8	10	10	9	8	7			
024		3	3	5	5	7	7	7	7	5			

Winds @ 30' except where noted

TABLE II C-21

METEOROLOGICAL SUMMARY:
RELATIVE HUMIDITY AND PRECIPITATION

1974-1975

Trailer	Item	Month											
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept
020	Rel. Hum, Hrly Max. (%)	100	100	100	96	98	100	99	100	98	99		
021		90	85	95	100	100	100	100	100	100	100		
022		100	100	100	100	100	100	100	100	100	99		
023		100	100	100	100	100	100	100	100	100	100		
024		100	100	100	100	100	100	100	100	95	96		
020	Rel. Hum, Hrly Min. (%)	10	22	23	24	22	23	15	12	9	10		
021		10	19	22	26	29	30	22	12	8	10		
022		14	26	27	30	27	28	19	17	19	21		
023		20	24	25	26	32	37	32	28	25	28		
024		16	25	25	26	26	28	16	16	11	12		
020	Rel. Hum, Hrly Avg. (%)	62	66	72	66	65	64	56	54	47	49		
021		62	63	74	75	73	70	65	58	53	56		
022		69	70	74	71	71	70	61	58	59	57		
023		53	63	69	68	72	72	67	64	54	54		
024		56	62	69	65	66	66	55	51	38	45		
020	Precip., 5-Min. Max. (Inches)				0.02		0.02	0.02	0.03	.08	.03		
021					0.02	0.02	0.01	0.01	0.12	.17	.09		
022				0.01	0.03	0.01	0.04	0.02	0.03	.05	.13		
023					0.04	0.01	0.02	0.03	0.05	.09	.20		
024				0.01	0.01	0.01	0.02	0.03	0.03	.02	-		
020	Precip., 1-Hr. Max. (Inches)				0.05	0	0.08	0.05	0.08	.10	.09		
021					0.04	0.02	0.06	0.03	0.18	.36	.11		
022					0.05	0.02	0.07	0.10	0.12	.05	.33		
023					0.08	0.01	0.08	0.13	0.16	.14	.33		
024				0.01	0.03	0.03	0.07	0.10	0.06	.03	0		
020	Precip., Monthly Tot. (Inches)				0.18	0	0.31	0.32	0.25	.28	.41		
021					0.25	0.04	0.45	0.20	0.51	.73	.30		
022				0.02	0.20	0.08	0.38	0.42	0.54	.10	.85		
023					0.38	0.06	0.51	0.49	1.22	.27	.53		
024				0.01	0.20	0.13	0.72	0.66	0.57	.07	0		

humidities range from 100% every month down to values as low as 8%(June); 80% diurnal variations in humidity are not uncommon, particularly in the valley. Heaviest monthly precipitation to date on the plateau has been 1.22 inches (May) and 0.85 inches (July) in Piceance Creek.

Maximum wind speeds (5-min.) have reached 56 MPH with gusts to 79 MPH on the plateau in April. Hourly average wind speeds have ranged from 2 to 10 MPH, generally higher on the plateau. Typical monthly wind roses on the plateau and in the valley are presented in Figures II C-2 and II C-3 for Trailer 023 and 021, respectively (new data for May - July). The predominant wind direction on the plateau is south-southwest, whereas that at Rock School in Piceance Creek Valley follows general southeasterly (down-valley) - northwesterly (up-valley) directions, dictated by the valley wall topography. The perspective of the whole windfield is now enhanced by the addition of the three new MRI mechanical weather stations (Figure II C-1) as indicated on Figure II C-4 in four intervals on July 24-25, 1975 (as a typical day). The windfield shown is at 30 feet above the surface; MRI wind speed magnitudes at 7 feet elevation. Note the general up-valley flow direction at 1200 and 1800 hours switching to down-valley for 2400 and 0600 hours. Knowledge of the near-surface windfield patterns is important, relative to the understanding of atmospheric diffusion of pollutants from both plant stacks and vehicular traffic.

II C-2 Low Altitude Meteorology

Low altitude meteorological data are obtained at 8, 30, 100, and 200 feet on the meteorological tower at Stations 023.

The quarterly wind rose at the 100 foot level on the tower (Figure II C-5) indicates that the predominant wind direction is from the south-southwest, similar to the previous quarter (December - February). Winds of the previous period were predominantly southerly.

Not only is the horizontal wind pattern important, its vertical structure also influences atmospheric diffusion. Based on tower data, the vertical variation of wind speed with height above the surface has been "fit" to a logarithmic equation of the form shown on Figure II C-6 for mean hourly speeds for each month. This is, the constants (V^*/k) and z_o were varied each month and are shown on the figure; (V^* = friction velocity, $k = 0.4$ = von Karman's constant, z_o = roughness length.) Data points shown correspond to mean hourly speeds and the lines shown are the derived equations from these data points, indicating the "goodness of fit." Fitting a more complex equation to these data was not justified, inasmuch as the data are rounded-off whole-number values in the data-reduction process.

Pasquill-Gifford atmospheric stability classes have been estimated

FIGURE II C-2

STATION 023 30' ELEVATION WIND ROSES ('74-'75)

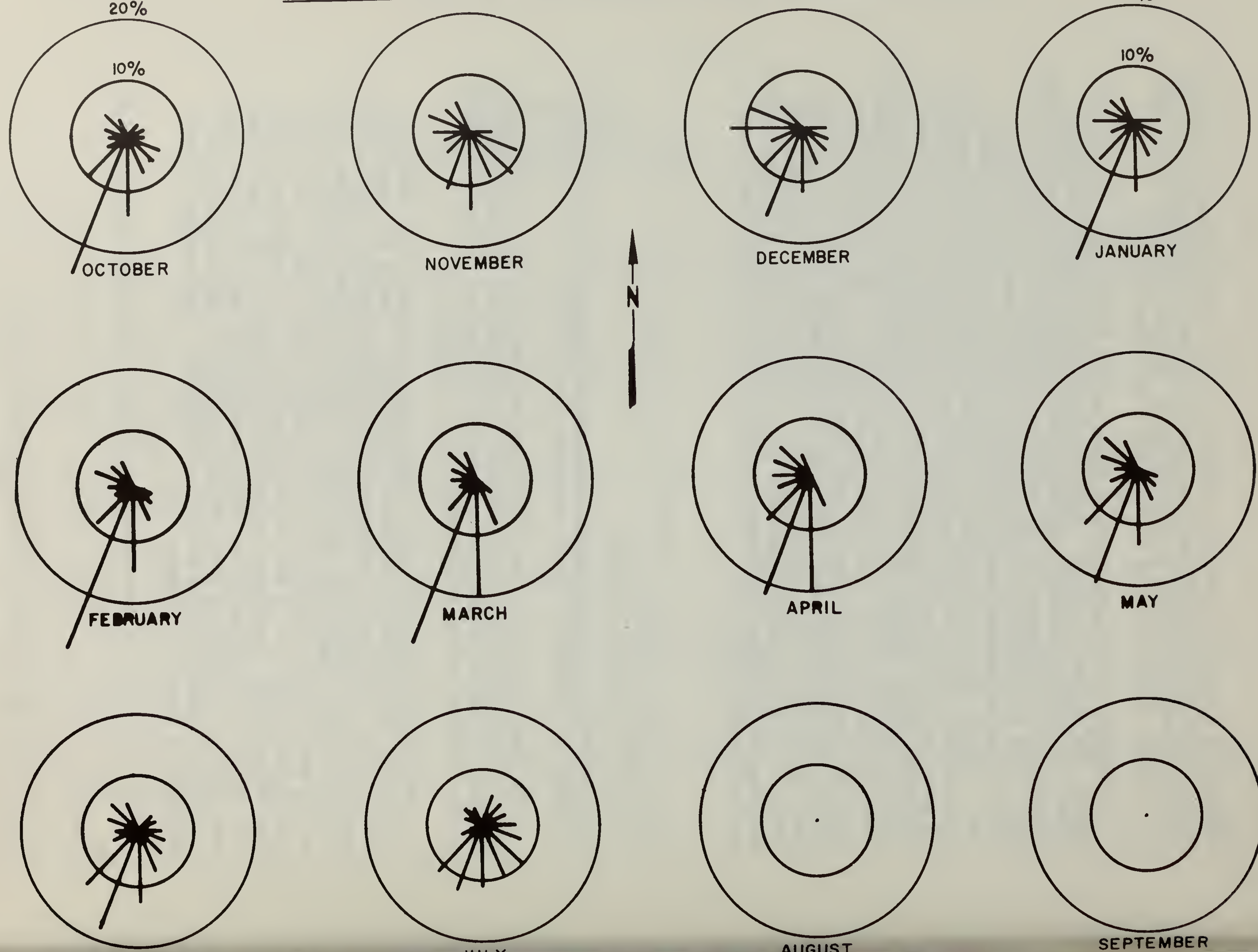
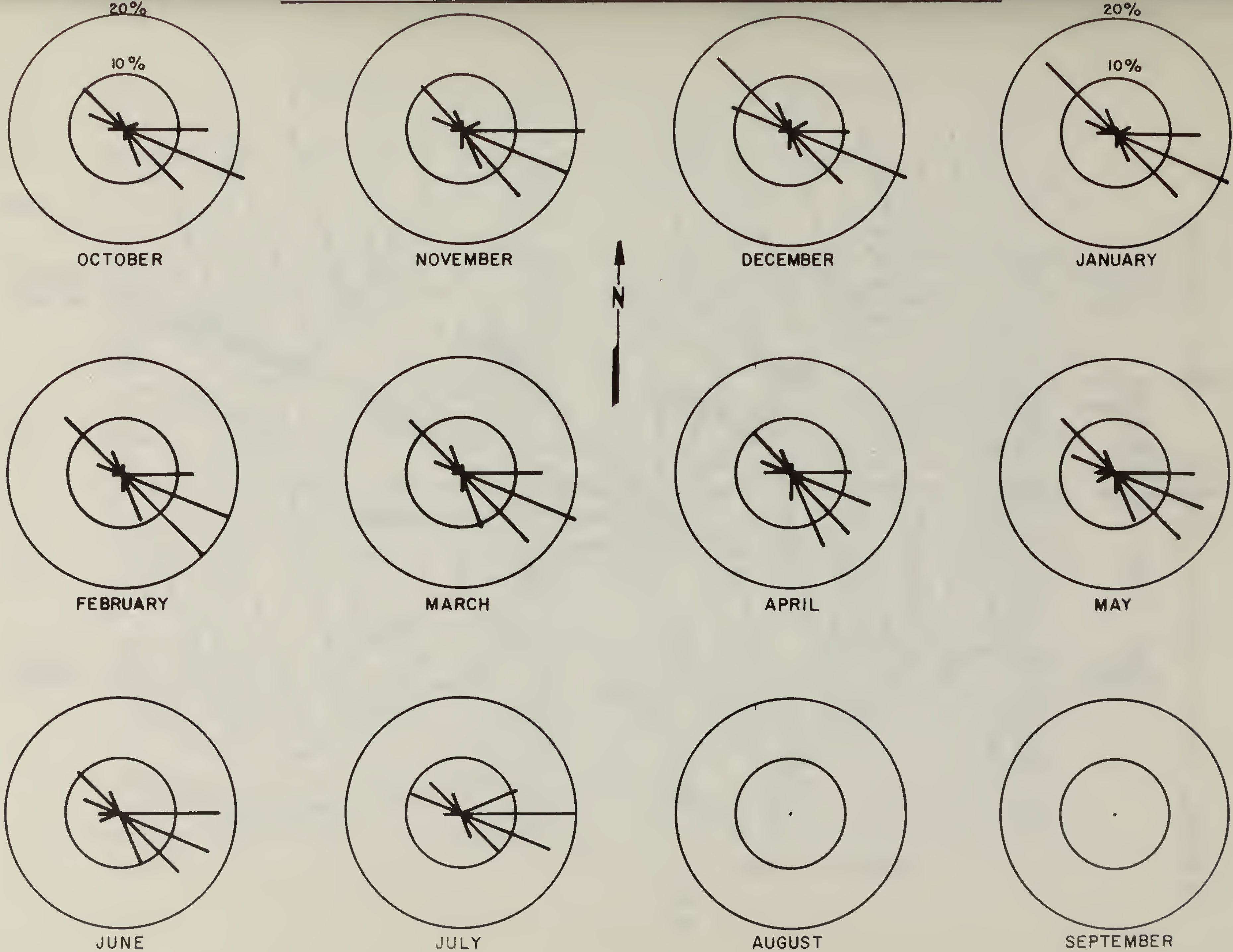
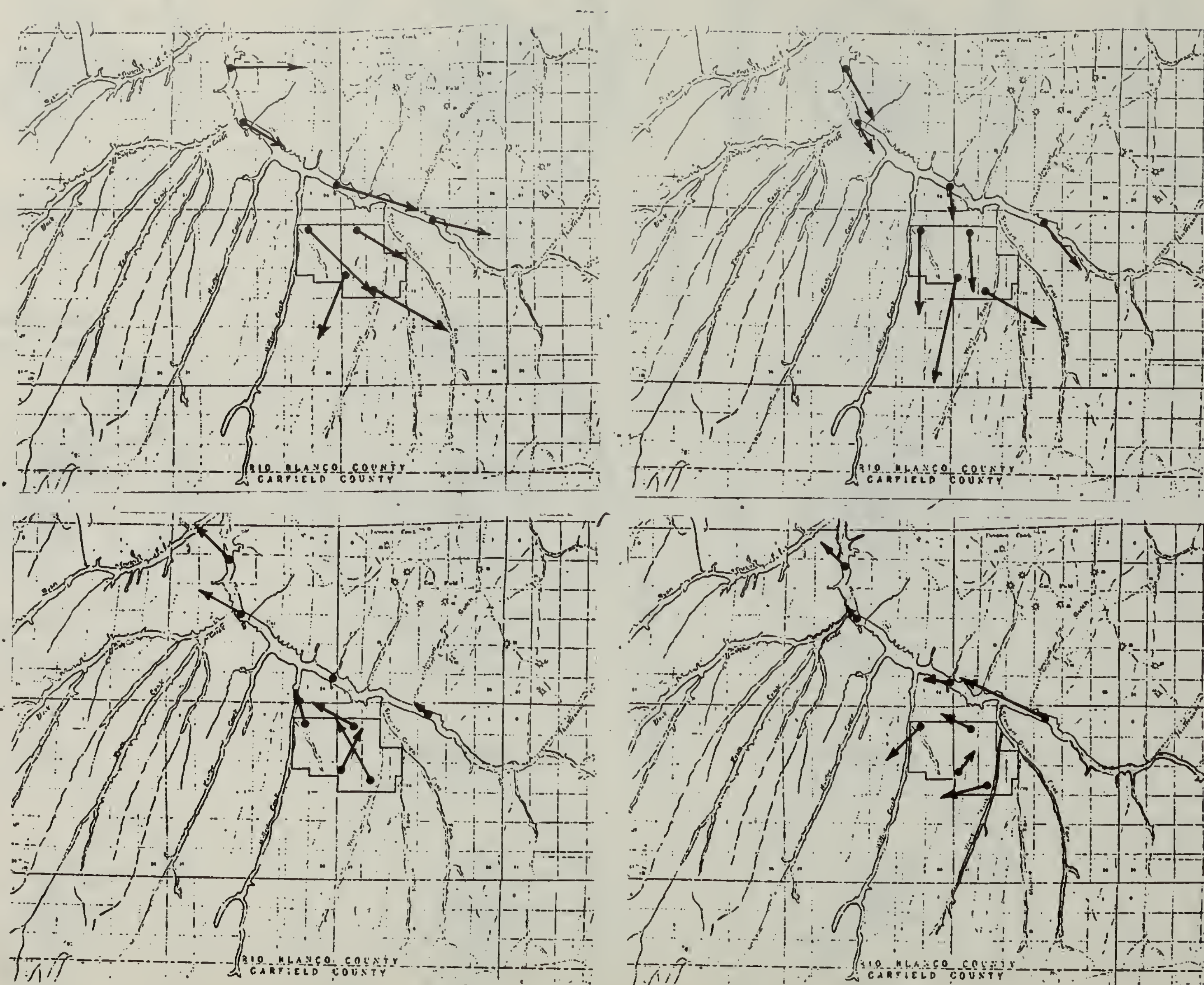


FIGURE II-C-3 STATION 021 30' ELEVATION WIND ROSES ('74-'75)





1200 HRS.
JULY 24

1800 HRS.
JULY 24

2400 HRS.
JULY 24

0600 HRS.
JULY 25

WIND PATTERNS
ON JULY 24-25
(30')

SCALE: ⟵ = 10 MPH

FIGURE II C-4

FIGURE II C- 5

QUARTERLY WIND ROSE-100' LEVEL

MAR. 75-MAY 75

TOTAL % OF CALMS DISTRIBUTED (0.14%)
TOTAL NO. OF 5-MIN. SAMPLES-21,509

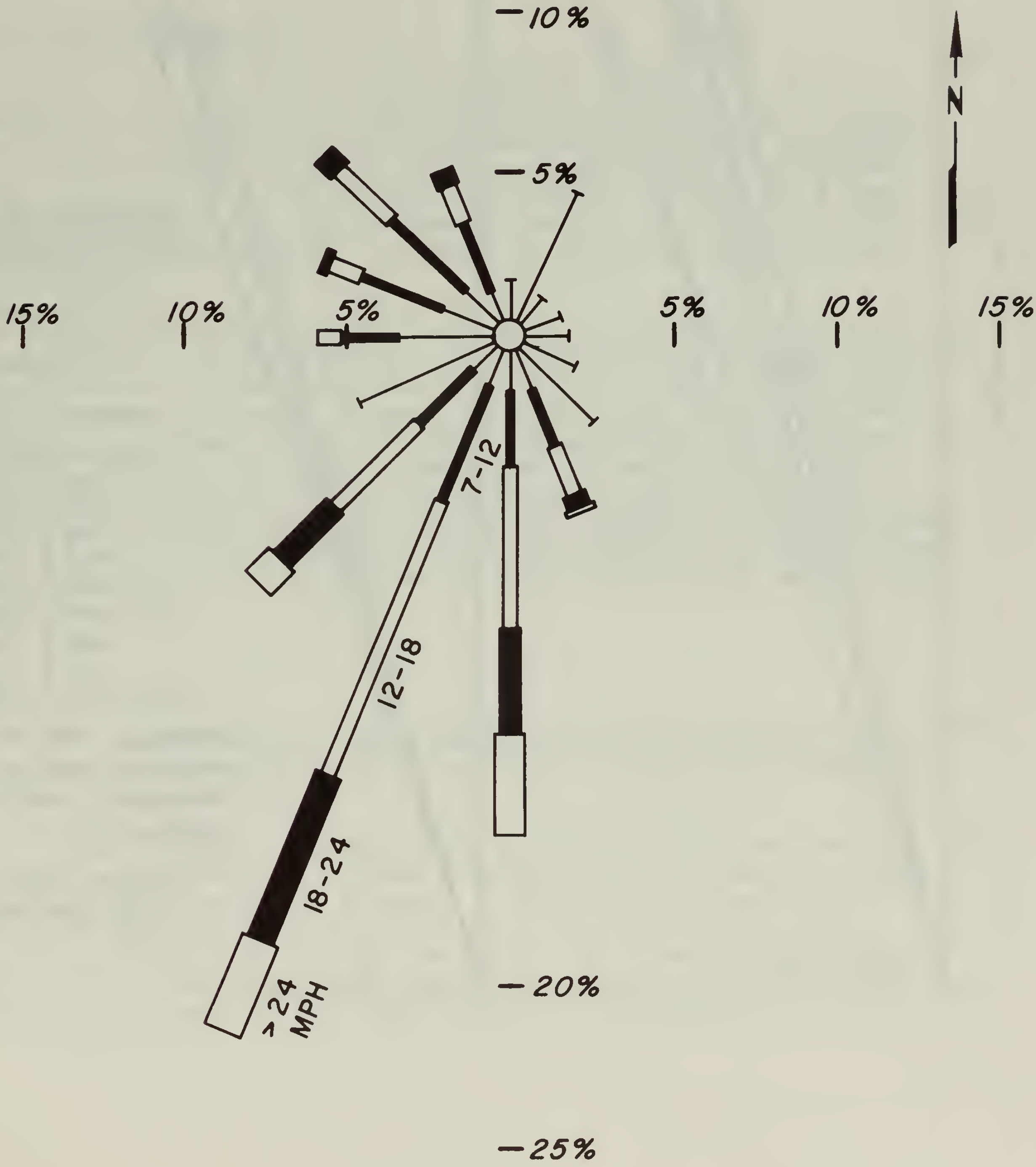
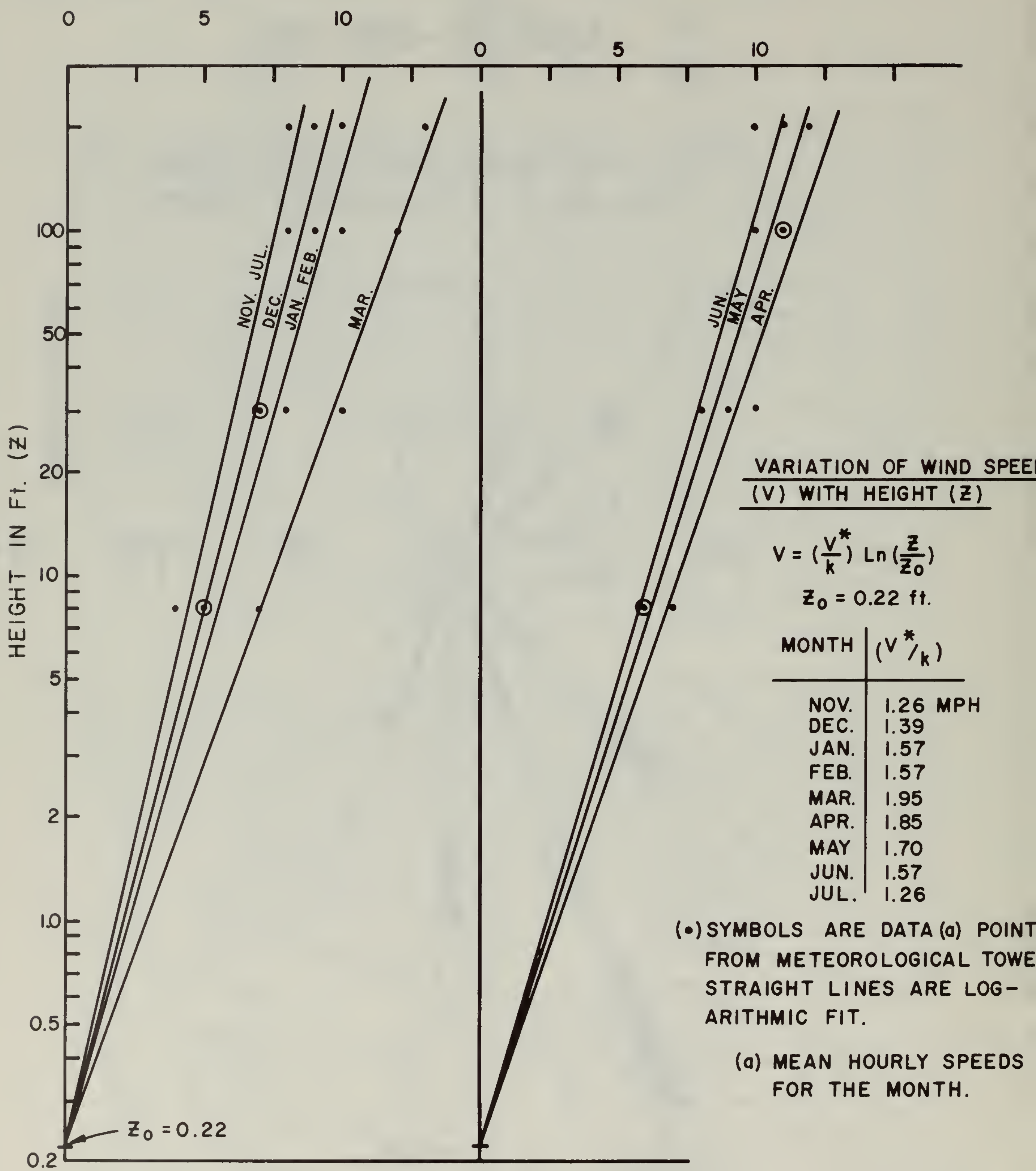


FIGURE II C-6

HORIZONTAL WIND SPEED (V) MPH



for use in diffusion studies for each hour of each month from temperature-difference data (30 foot level to 200 foot level) on the tower (Table II C-22). Stability class frequencies by month are presented on Table II C-23. The range of variation in slope of the temperature-height curve corresponding to each class is indicated on the latter Table; the reader should recall that Class A is most unstable (lots of mixing and diffusion) and Class F the most stable (restricted mixing). Data for July on Tables II C-22 and II C-23 are incomplete. Note the higher frequency of the A category in the spring and summer, as opposed to D, E, and F in the winter. Major seasonal changes in class occur in late morning to late afternoon, whereas the class existing from late-evening to early-morning is relatively insensitive to seasonal change.

II C-3 Upper Air Studies

Four 15-day quarters of upper atmospheric studies have now been completed. On Table II C-24 are presented the number of days for which inversions have occurred in Piceance Valley below the Tract (designated "C"), above the Tract surface at the meteorological tower (designated "T"), days with "C" or "T" and days with both "C" and "T." On a cumulative basis for the year, the percentages are 57.2, 76.8, 89.2 and 44.6 respectively. Unexpectedly, the summer period had the highest number of inversions.

During this reporting period a second acoustic sounder was installed, this one at the Rock School site at Station 021 in Piceance Valley. (The other one is on the plateau at Station 023.) Tables II C-25 and II C-26 show the following inversion characteristics for both sounders: number of inversions, average duration, average height, and inversion duration frequency. In general, inversions in Piceance Valley last longer, are at a lower average height, but are roughly of equal number with those on the plateau. The aircraft data indicated a higher frequency on Tract but it must be recognized that the aircarft cannot fly at Piceance Valley altitude in the dark so that it tends to miss a few early-morning valley inversions.

II C-4 Visibility

There are no visibility requirements in the Lease Stipulations; site visibility measurements are required in the Conditions of Approval by the Mining Supervisor.

A joint proposal request with the C-a Tract has been prepared and a contract go-ahead given to Dames and Moore; work is expected to start operationally approximately October 1. The shelter has been constructed and installed at the Hunter Creek site. The selected area-wide technique utilizes photographic photometry. The visual range will be measured every sixth day during a one year period. On that day, photographs will be taken of four views covering an approximate 90° north to

Table II C-22

Average Hourly Stability Classes DT2

Month	Hour																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Nov '74	E	E	E	E	E	E	E	F	F	F	F	F	F	F	E	E	E	E	E	E	E	E	E	E
Dec	E	D	D	E	D	D	E	E	E	F	F	F	F	E	E	E	E	D	D	D	D	D	D	D
Jan '75	D	D	D	D	D	D	D	D	E	E	E	E	E	E	E	E	D	D	D	D	D	D	D	D
Feb	E	E	E	E	E	E	E	E	E	D	D	C	C	C	C	C	D	E	E	E	E	E	E	E
Mar	D	D	D	D	D	C	C	C	A	A	A	A	A	A	A	A	A	A	C	C	D	D	D	D
Apr	D	D	D	D	D	D	C	B	B	B	A	A	A	A	A	A	A	B	C	D	D	D	D	D
May	D	D	D	D	D	D	C	B	A	A	A	A	A	A	A	A	A	A	B	C	D	D	D	D
June	E	E	E	E	E	E	D	B	A	A	A	A	A	A	A	A	B	B	B	C	D	D	E	E
July	-	-	-	-	-	-	-	-	-	-	-	A	A	A	A	A	A	B	-	-	-	-	-	-
Aug																								
Sept																								
Oct																								

Table II C-23
Meteorological Summary:
Stability Class Frequencies (%)
1974 - 1975

Source: Tower DT2
(30' to 200')

Pasquill - Gifford Stability Class	dT/dz Range for this Stability Class ($^{o}C/100m$)	Month											
		Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
A	< - 1.9	2.0	17.4	12.5	6.3	45.4	48.4	57.2	42.9	75			
B	-1.9 to -1.7	0.4	1.3	2.7	1.5	6.5	4.1	3.1	4.6	25			
C	-1.7 to -1.5	0	1.5	3.8	0.7	6.5	3.9	2.8	4.4	0			
D	-1.5 to -0.5	5.3	19.0	22.6	33.7	27.0	20.6	12.3	16.1	0			
E	-0.5 to +1.5	62.8	40.3	31.5	41.8	14.1	17.7	12.2	17.7	0			
F	>1.5	29.5	20.5	26.9	16.0	0.5	5.3	12.4	14.3	0			
Total		100	100	100	100	100	100	100	100	100			

TABLE II C-24

SUMMARY OF INVERSIONS AT THE C-b TRACT

(Source: Temperature vs. Altitude Data)

Item	Fall '74 (Oct.)	Winter '75 (Jan.)	Spring '75 (Apr.)	Summer '75 (July)	Cumulative
No. of Days with Inversions					
In Canyons below Tract (=C)	4	8	5	15	32
Above Tract Surface (=T)	11	11	7	14	43
C or T	12	13	10	15	50
C and T	3	6	2	14	25
No. of Successful* Days without Inversions	0	2	4	0	6
Total No. of Successful* Days	12	15	14	15	56
Percentage of Days with Inversions					
C	33.3	53.3	35.7	100.	57.2
T	91.6	73.3	50.0	93.3	76.8
C or T	100.0	86.6	71.4	100.	89.2
C and T	25.0	40.0	14.3	93.3	44.6

*A "success" is defined here as one for which (a)at least two successful flights were obtained and for which one of the flights was either at nominally 6 am or 9 am or (b) one inversion was obtained.

TABLE II C-25

AIR TEMPERATURE INVERSION CHARACTERISTICS

June 1, 1975 to August 31, 1975.

	Sounder @ Sta. 023			Sounder @ Sta. 021		
	June	July	August	June	July	August
Number of inversions	--	33	8	--	30	10
Average duration (hours)	--	2.7	3.5	--	5.6	5.9
Average height (feet)	--	1202	1155	--	1023	915
Number of days of measurement	0	15	8	0	14	5
Number of days of missing data	30	16	23	30	17	26

TABLE II C-26

FREQUENCY ANALYSIS OF AIR TEMPERATURE INVERSION DURATION

June 1, 1975 to August 31, 1975.

Inversion Duration (Hours)	Sounder @ Sta. 023				Sounder @ Sta. 021			
	July	August	Total	Percent	July	August	Total	Percent
0 - 3.9	25	6	31	76	12	4	16	40
4 - 6.9	7	1	8	19.5	7	3	10	25
7 - 9.9	1	1	2	4.5	5	0	5	12.5
10 - 12.9	0	0	0	0	6	2	8	20
13 - 15	0	0	0	0	0	1	1	2.5

east sector looking across the Roan Plateau from the Hunter Creek site. Each view will be shot seven times throughout the day with black and white and color film. The contrast between the object image and the background sky is used to compute the visual range in miles.

II C-5 Noise

This program will document baseline levels of noise on Tract C-b and along the roads leading to the Tract. Actual noise level measurements will complement traffic noise predictions made from Colorado State Highway statistics.

A General Radio 1565-B Sound-Level Meter is used to record the noise level at the following locations (See Figure II C-7):

1. Two locations along Piceance Creek road near the Tract:

   a. Junction of Collins Gulch road and Piceance Creek road, Location No. I.

   b. Piceance Creek road 3/8 of a mile east of P-1 road turn-off, Location No. II.

      - Utilizing A weighting*, fast meter response, peak noise level is measured for five passing vehicles. Type and condition of vehicle and distance from the centerline of lane of travel are recorded as well as background noise at each location for A-, B-, and C-weighting.

      - Measurements are made at the selected sites, appropriately marked, 50' to 1,000' from centerline of lane of travel.

2. Location near proposed plant site: Corehole SG-10 drill pad, Location No. III.

3. Locations at intervals away from mine and plant site, suitable for monitoring plant noise at some future date.

   a. Near Corehole SG-11, Location No. IV.

   b. Vegetation site on ridge between Little Scandard Gulch and Willow Creek near SG-9, Location No. V.

   c. Near Corehole C-b 2 (2b), Location No. VI.

* "A-weighting" is a weighting technique to approximate the response of the human ear to noise of various frequencies. Measurements are recorded in dB (A), the A-weighted sound level in decibels.

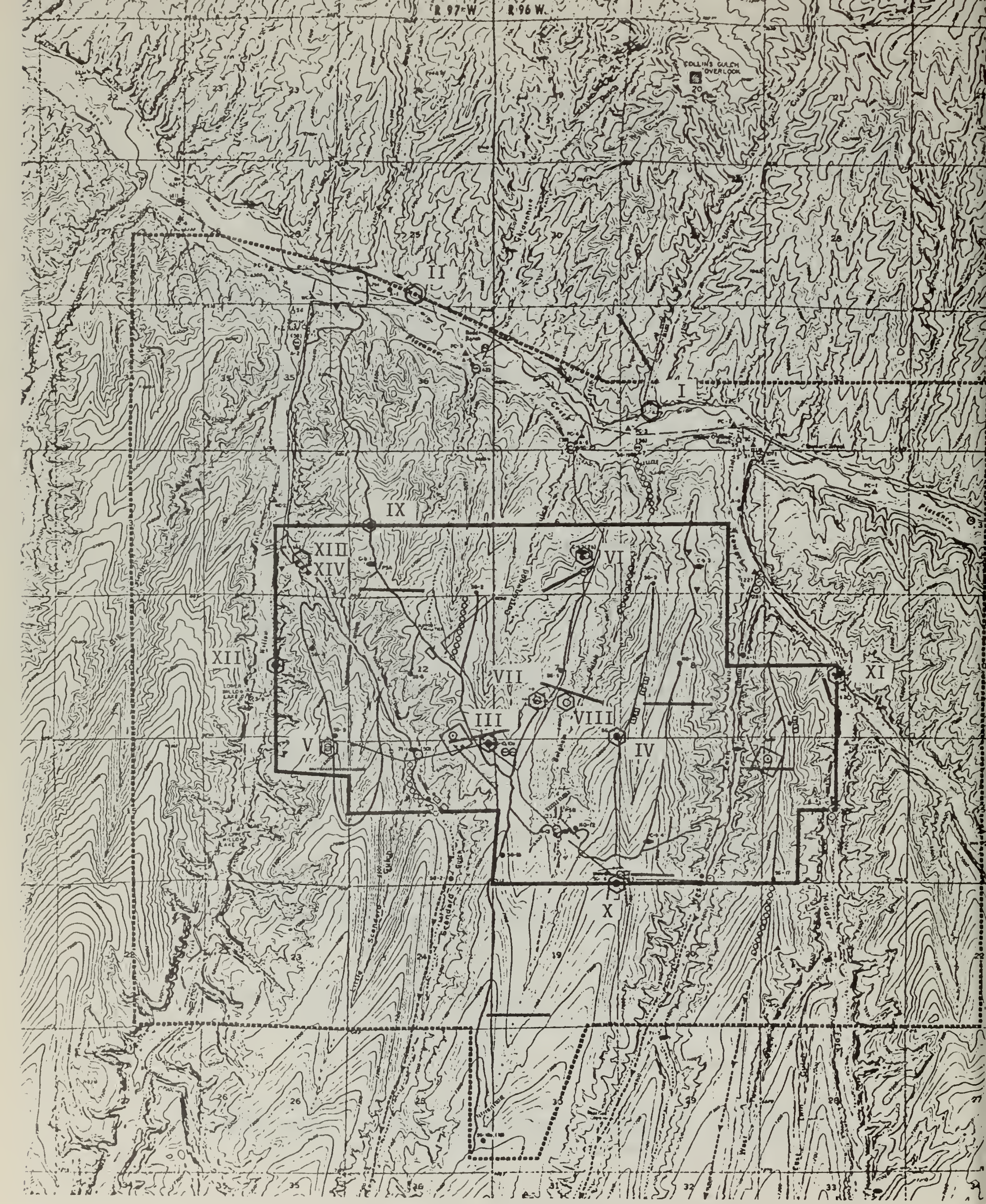


FIGURE II C-7
Tract C-b Noise Level Measurement Locations
○ NOISE LEVEL Measurement Location
I LOCATION NUMBER

4. Proposed mine shaft site and mine surface facilities site, aquifer test site well, AT-1, Location No. VII.

5. Location near process shale disposal conveyor; 1/8 to 1/4 mile directly east of aquifer test site well, AT-1, Location No. VIII.

6. Locations at Tract boundaries to monitor cumulative noise levels from operations on Tract:

   a. North: Intersection of Tract boundary and Tract C-b access road, Location No. IX.

   b. South: Tract boundary near the vegetation sites near SG-16, Location No. X.

   c. East: Tract boundary near SG-8 or alluvial well A-9, Location No. XI.

   d. West: Willow Creek road near the center of western Tract boundary, Location No. XII.

7. Location in valley bottom and ridge top remote from expected areas of activity or disturbance: SG-1 drill pad site and ridge near SG-1 drill pad site.

   - Valley, Location No. XIII

   -Ridge, Location No. XIV

At each of the above sites, the peak measurement reading on the A-, B-, and C-weighting scales is recorded. Measurements are made on a monthly basis for one year. Table II C-27 indicates the August data.

Colorado State Highway data have been used with a correlation curve to estimate traffic noise levels in the Piceance Creek Basin and surrounding areas as shown in Table II C-28 for the 13 traffic sampling stations shown on Figure II C-8.

II C-6 Atmospheric Diffusion Studies

Phase I of these studies has been completed utilizing a Gaussian plume model with modified Briggs plume-rise equations for dispersion of stack effluents and a simplified "box" model in segments of Piceance Canyon for auto and truck emission dispersion-analysis.

Phase I did not have available one complete year of meteorological data; thus it was deemed adequate to utilize average hourly values for one representative month for each quarter with the summer quarter estimated.

TABLE II C-27

TRACT C-b NOISE STUDY DATA SHEET

Name: Jean M. Bissett

Date: 8/21/75 *** 8/22/75

Location Number	Time (MST)	Meter Reading at Weighting: A	B	C	Re- sponse (1) S	F	Position of Observer* Standing; Height of Inst. 6'	Micro- phone ⊥ Noise **	Other (Vehicle Information)
I. Collins Gulch	1210	46	47	62	X			Yes	
1.						X	Standing Facing West; 6'		No Cars Passed
2.						X	" " "		" " "
3.						X	" " "		" " "
4.						X	" " "		" " "
5.						X	" " "		
II. P. Creek E. of PL Gate	1020	46	48	62	s			Yes	Background from Centerline 2';
*** 1.	1020	60				X	Standing Facing North; 6'		'73 Jeep Wagoneer, Good Condition
2.		58				X	" " "		2'; '72 Chevy Blazer, Good
3.		67				X	" " "		Toyota, Good
4.		74				X	" " "		VW - New
5.		65				X	" " "		Chevy Blazer, Goo
III. SG-10	1147	46	48	62	X		Facing SE; Standing	Yes ⊥ NE of SG-10	
IV. SG-11	1125	53	45	49	X		S of SG-11, Facing N	Yes ⊥	
V. SG-9	0943 ***	46	46	52	X		S of SG-9 on Road Facing W	Yes ⊥	
VI. C-b2b	1032	46	47	54	X		Facing W	Yes	⊥ To Minesite
VII. AT-1	1019	45	45	45F	s		Facing N	Yes	
VIII. SE of AT-1 I Conveyor	1152	46	47	66/46	X		Facing N	Yes	c-Reading on Chopper in Dista
IX. Boundary (N)	*** 1042	46	47	62	X		R of Sign Facing P. Creek	Yes	
X. SG-16 (S)	1135	45	47	62	X		Section Corner Facing N	Yes	Windy
XI. SG-8 (E)	1105***	46	50	61	X				
XII. Willow Creek (W)	*** 0850	47	48	51	X		E Side of Road on Bank	Yes	
XIII. SG-1, Valley	*** 0900	46	51	62	X		Facing W; Standing 10' W of Sign	Yes	Windy
XIV. SG-1, Ridge	*** 0930	48	48	55	X		Sitting on Finger Rock Facing Willow C. to N.	Yes	Windy

Meter Type: General Radio 1565-B Meter I.D. No.: 28612 Microphone Serial No.: 44682

* Posture; direction facing; height of meter above ground level

** Should be perpendicular to noise path

(1) S = Slow; F = Fast

TABLE II C-28

APPROXIMATE TRAFFIC NOISE LEVELS AT LOCATIONS IN PICEANCE CREEK BASIN AND SURROUNDING AREAS[1]

(During peak hour of traffic, average 24-hour day, 1974)

Location Number	Location Description[2]	Noise Level[3] L_{10} dBA
1	S.H.[4] 64 east of Junction S.H. 64 & S.H. 139	62
2	S.H. 64 west of Junction S.H. 64 & S.H. 13	60
3	S.H. 64 east of Junction S.H. 64 & S.H. 13	59
4	S.H. 13 south of Junction S.H. 13 & S.H. 64	61
5	S.H. 13 at Junction S.H. 13 & Piceance Creek Road	61
6	S.H. 13 north of Junction S.H. 13 & S.H. 325	63
7	S.H. 325 east of Junction S.H. 13 & S.H. 325	58
8	S.H. 13 south of Junction S.H. 13 & S.H. 325	61
9	S.H. 6 east of Junction S.H. 6 and S.H. 13	66
10	S.H. 6 west of Junction S.H. 6 and S.H. 13	66
11	Piceance Creek Road west of Junction Piceance Creek Road & S.H. 13	53
12	Junction Piceance Creek Road and Local Road approximately 17.6 miles west of Junction Piceance Creek Road & S.H. 13	53
13	Piceance Creek Road south of Junction Piceance Creek Road and S.H. 64	53

(1) Noise levels predicted by utilizing 1974 Colorado State Highway Statistics, "Nomograph For Approximate Prediction of Highway Noise Levels," and data from Colorado State Highway Department Computer Program DFINCLS.

(2) Locations shown in Figure II C-8.

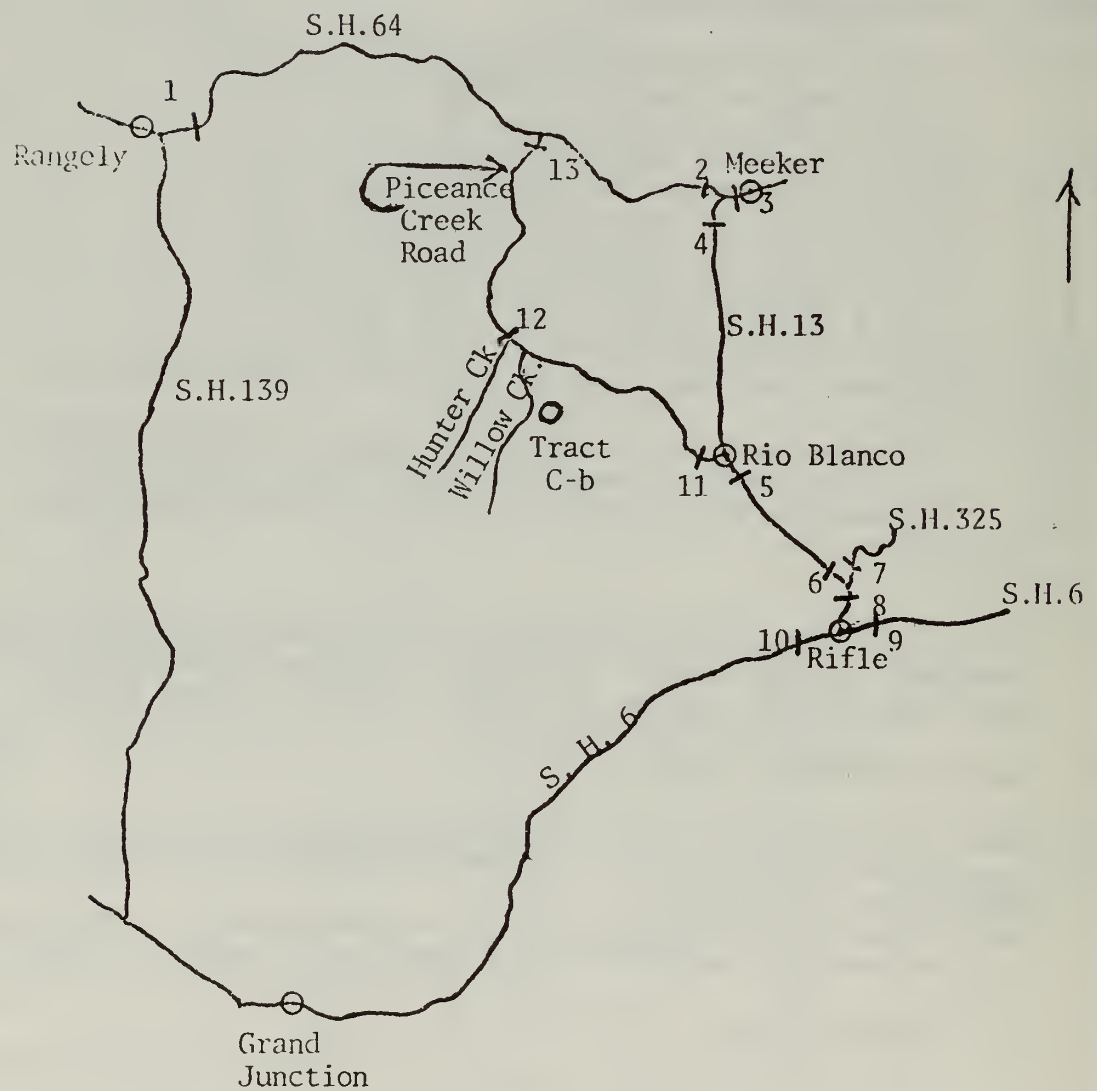
(3) Noise level at location 500 feet from highway.
L_{10} - the sound level that is exceeded 10 percent of the time for the time period under consideration (1 hour).
dBA - Noise level in decibels on "A" weighting scale, a weighting technique to approximate the response of the human ear to noise of various frequencies.

(4) S.H. - State Highway

FIGURE II C-8

STATE HIGHWAY TRAFFIC SAMPLING STATIONS

PICEANCE BASIN 1974



Legend

S.H.6 - State Highway 6

1 - 13 Traffic Sampling Stations
(Refer to Table II C-28)

Stack emissions, which served as an input to this analysis, are based principally on the Colony design and are presented in Table II C-29. Hourly concentrations on both 1 km. and 0.5 km. grid spacings were generated for sulfur dioxide, particulates, oxides of nitrogen, (NO_x) and total hydrocarbons (THC). Three-hour and twenty-four-hour average concentrations were then computed for each "quarter." Recognizing the limitations of these data, only 24-hour concentrations are presented on Table II C-30. Results should be interpreted as "indicators" and not in light of compliance or non-compliance at this early date.

Vehicular emissions are analyzed in the access corridors leading to Tract C-b, specifically for two segments of Piceance Creek road from the Tract C-a turnoff to the P-L Ranch and from the start of Piceance Creek Valley (on the east) to the P-L Ranch (Figure II C-9). A simple box-model was used to predict concentrations of NO_x, CO and THC in two portions of the Piceance Creek Valley for three inversion heights (150, 250, and 400 feet) and two wind speeds (2 and 6 MPH). Figure II C-10 illustrates a typical nomograph of the concentrations reached in the model at the end of one hour for CO in the east end of Piceance Creek Valley to the P-L Ranch to illustrate the method. Similar concentrations for both portions of Piceance Creek Valley are given on Figures II C-6 through II C-11 of _Quarterly Data Report #4_. for NO_x, CO and THC.

By way of example, during the construction phase a loading of 500 cars plus 20 trucks, traveling at an average speed of 35 MPH is assumed to be a representative maximum in the eastern segment of Piceance Creek road during an early-morning shift change. If an altitude of 6500' and an average model year of 1973 are assumed, then EPA and State-of-Colorado-supplied auto and truck emission factors and speed/altitude correction factors yield emission rates of 52700 gm./hr. of nitrogen oxide, 987,000 gm./hr. of carbon monoxide, and 73,900 gm./hr. of total hydrocarbons. Entering the nomographs referred to above at these abscissa values and representative wind speed of 6 MPH and inversion height of 150' yields maximum incremental concentrations at the end of one hour of 80 ug/m^3 for NO_x, 1800 ug/m^3 for CO, and 130 ug/m^3 for THC. These estimated concentrations are conservative since the actual travel time at 35 MPH in this 21 mile segment is only 36 minutes.

TABLE II C-29

STACK EMISSION PARAMETER CHARACTERISTICS

FOR THE HYDROTREATED SHALE OIL CASE

Stack*	Ht (m)	Rad (m)	Temp (^oK)	Vel (m/s)	Rate (gm/sec)			
					SO_2	NO_x	THC	PM
Preheat	95	1.5	350	15	7	180	35	35
Elutriator	95	1.0	375	15	12	15	--	30
H_2 Furnace	25	1.0	500	15	4	10	--	2
Sulfur Plant	65	1.0	400	10	10	--	--	--
Wetter	95	1.0	500	15	--	--	--	35

All numbers are approximate.

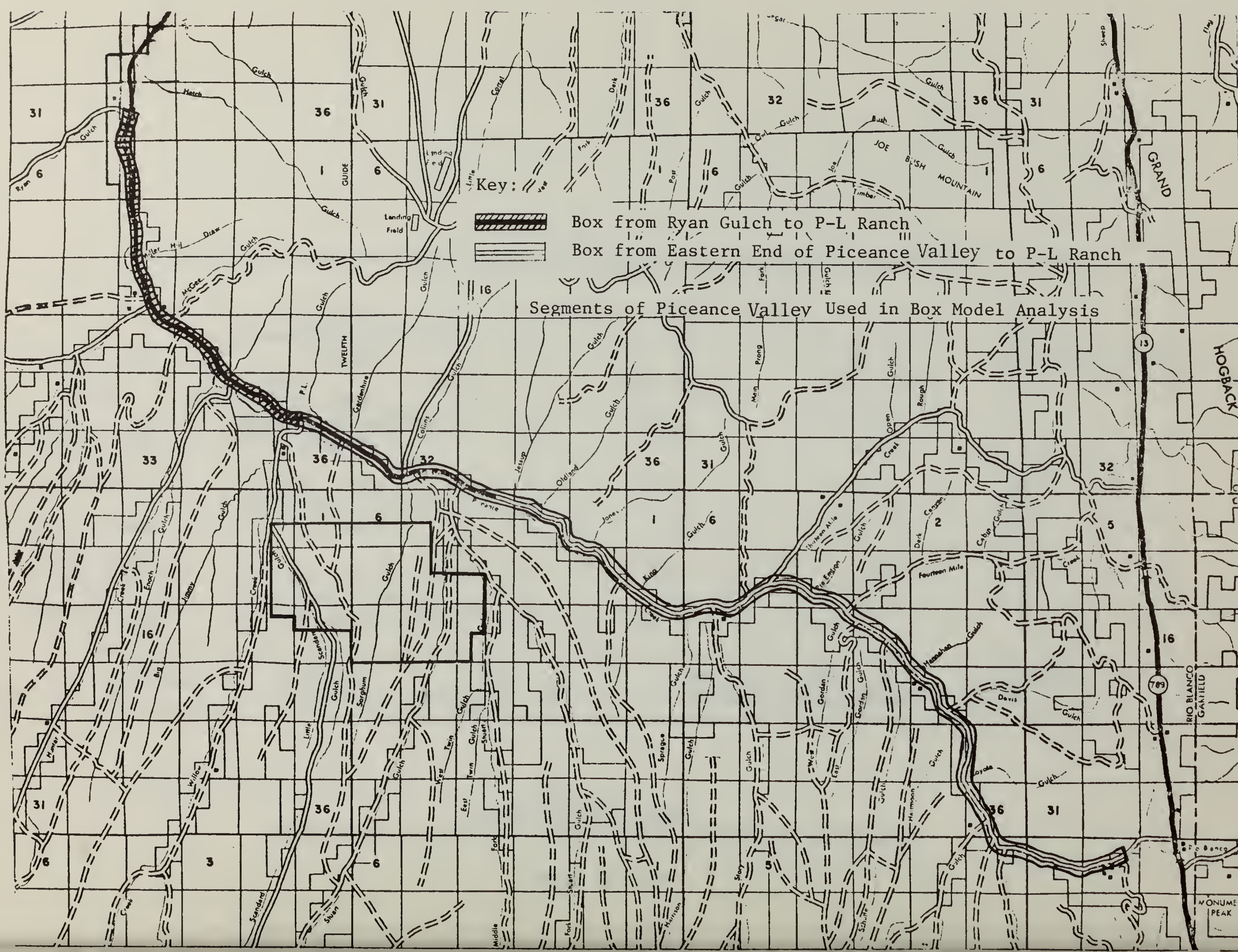
* Component Parts of Retort.

TABLE II C-30

PROJECTION OF TRACT C-b AMBIENT CONCENTRATIONS OF POLLUTANTS
24-Hour Maximum Values
(ug/m3)

Pollutant	Location	Oct. '74	"Representative" Month		July '75 (estimated)
			Jan. '75	Apr. '75	
SO_2	On Tract	0	1	7	9
	Near Tract Boundary	0	1	2	6
	Off Tract	2	3	3	6
NO_x	On Tract	0	1	35	34
	Near Tract Boundary	0	1	7	11
	Off Tract	10	12	10	28
THC	On Tract	0	0	5	5
	Near Tract Boundary	0	0	1	4
	Off Tract	1	1	1	4
PM	On Tract	0	1	19	19
	Near Tract Boundary	0	1	4	15
	Off Tract	3	7	6	15

FIGURE II C-9



Key:
Box from Ryan Gulch to P-L Ranch
Box from Eastern End of Piceance Valley to P-L Ranch
Segments of Piceance Valley Used in Box Model Analysis
GRAND
HOGBACK
JOE BUSH MOUNTAIN
RIO BLANCO
GARFIELD
MONUMENT PEAK
Landing Field

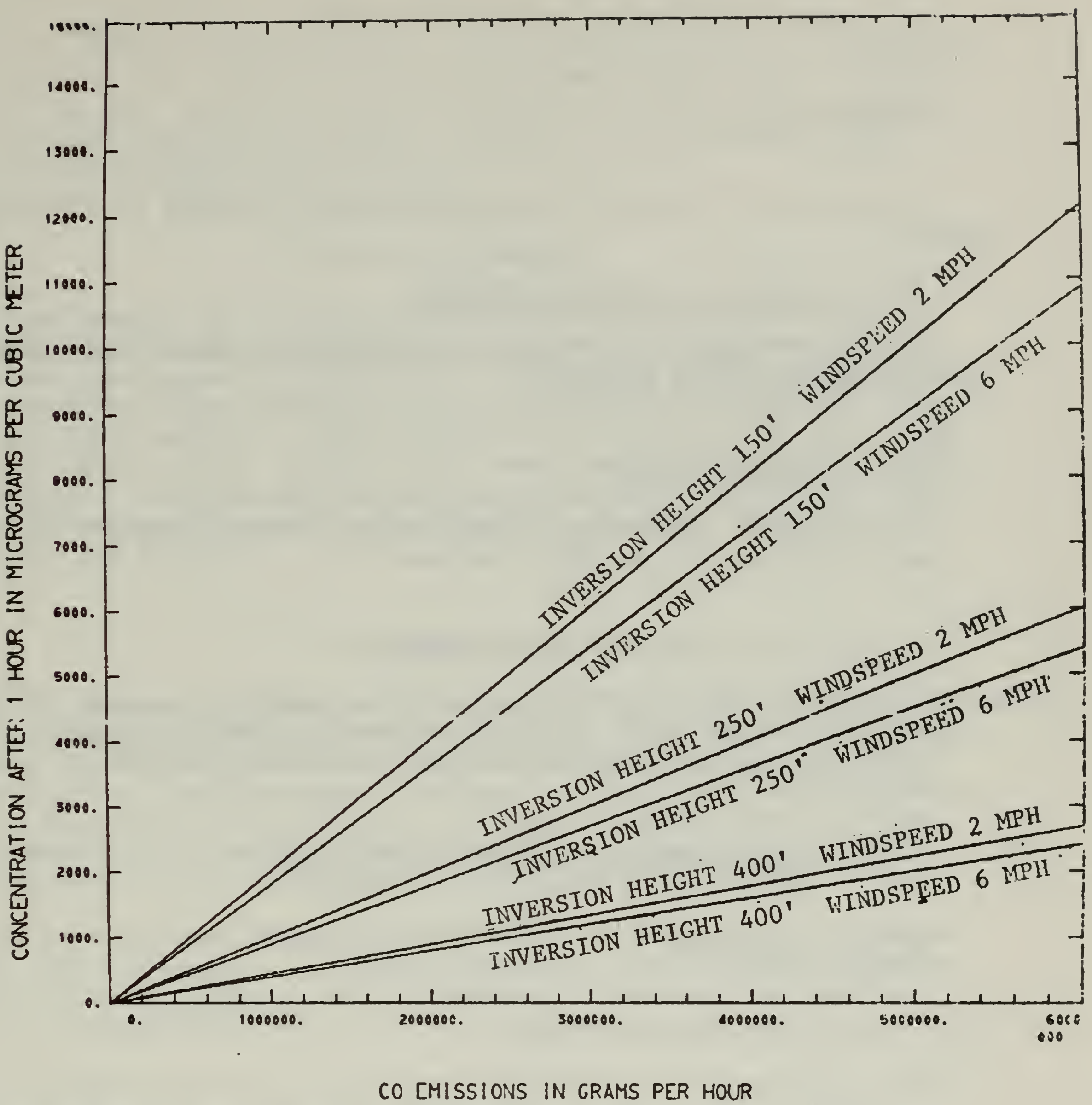


FIGURE II C-10 CO EMMISSIONS FOR EAST END OF PICEANCE CREEK VALLEY TO P-L RANCH

II D BIOLOGY

The biological studies in this quarter are discussed in the following sections:

II D-1 Terrestrial Wildlife Studies

Big Game, Medium-Sized Mammals, Small Mammals, Birds, Amphibians and Reptiles, and Arthropods

II D-2 Aquatic Studies

Fish, Benthos, Periphyton, Phytoplankton Primary Productivity, Water Quality, and Sediment Analyses

II D-3 Terrestrial Vegetation Studies

Flora, Vegetation Mapping and Additional Sampling Program, Intensive Study Sites, Productivity Studies, Phenology and Shrub Growth, and Decomposition and Litter Accumulation

II D-4 Dendrochronology and Dendroclimatology

II D-5 Soil Survey

II D-1 Terrestrial Wildlife Studies

Big Game

During this quarter, mortality data gathered during early spring were analyzed. These mortality data were gathered from quadrats located in five habitat types: 1) pinyon-juniper woodland; 2) chained pinyon-juniper; 3) valley sagebrush; 4) lower valleys near agricultural meadows; and 5) small lateral draws. Deer carcasses encountered were tallied. The age at death, year of death, cause of death (where possible), and habitat type where death occurred were recorded. Criteria were established to classify a deer carcass and year of death. Established methods were utilized to determine age at death and attempt to determine cause of death.

The greatest numbers of deer carcasses were found in the lower valleys and small draws (Table II D-1). These represent total deer deaths over several years for Tract C-b and vicinity. The majority of deaths occur in fawns (Figure II D-1), indicating that the probability of death is greatest in the first year of life. Causes of death could be determined in some cases, e.g., the 1974-75 road kills and predator kills. Of the total of 171 deer carcasses examined, 29 (17%) were deer deaths which occurred during the previous winter (1974-75). Three predator kills were recorded (2 coyote; one unknown).

Medium-Sized Mammals

A continuation of the track count study initiated in the fall of 1974 revealed that cottontail rabbit tracks were the most numerous of the medium-sized mammals (Table II D-2). They were present in the pinyon-juniper woodland, upper sagebrush valleys, and lower agricultural valleys and agricultural meadows. Coyote tracks were counted in the upper sagebrush and lower valleys. Bobcat tracks were observed in the upper sagebrush valleys. No other medium-sized mammal tracks were counted in July although a red squirrel was observed south of the Tract boundaries in the Douglas fir forest.

Small Mammals

During the June and July 1975 trapping period, eleven different species of small mammals were live-trapped (Table II D-3). This total included six species at Grid 1, four species at Grid 2 and eleven species from the nine satellites. The deer mouse continues to be the most abundant small rodent. All species encountered but two have been previously captured. Two new species have been positively identified, Zapus princeps, the western jumping mouse, and Peromyscus truei, the pinyon mouse.

Density estimates remained generally low at Grids 1 and 2 compared to fall, 1974, estimates. A limited number of species showed increased densities from spring (May, 1975) estimates. These were the montane vole and the deer mouse.

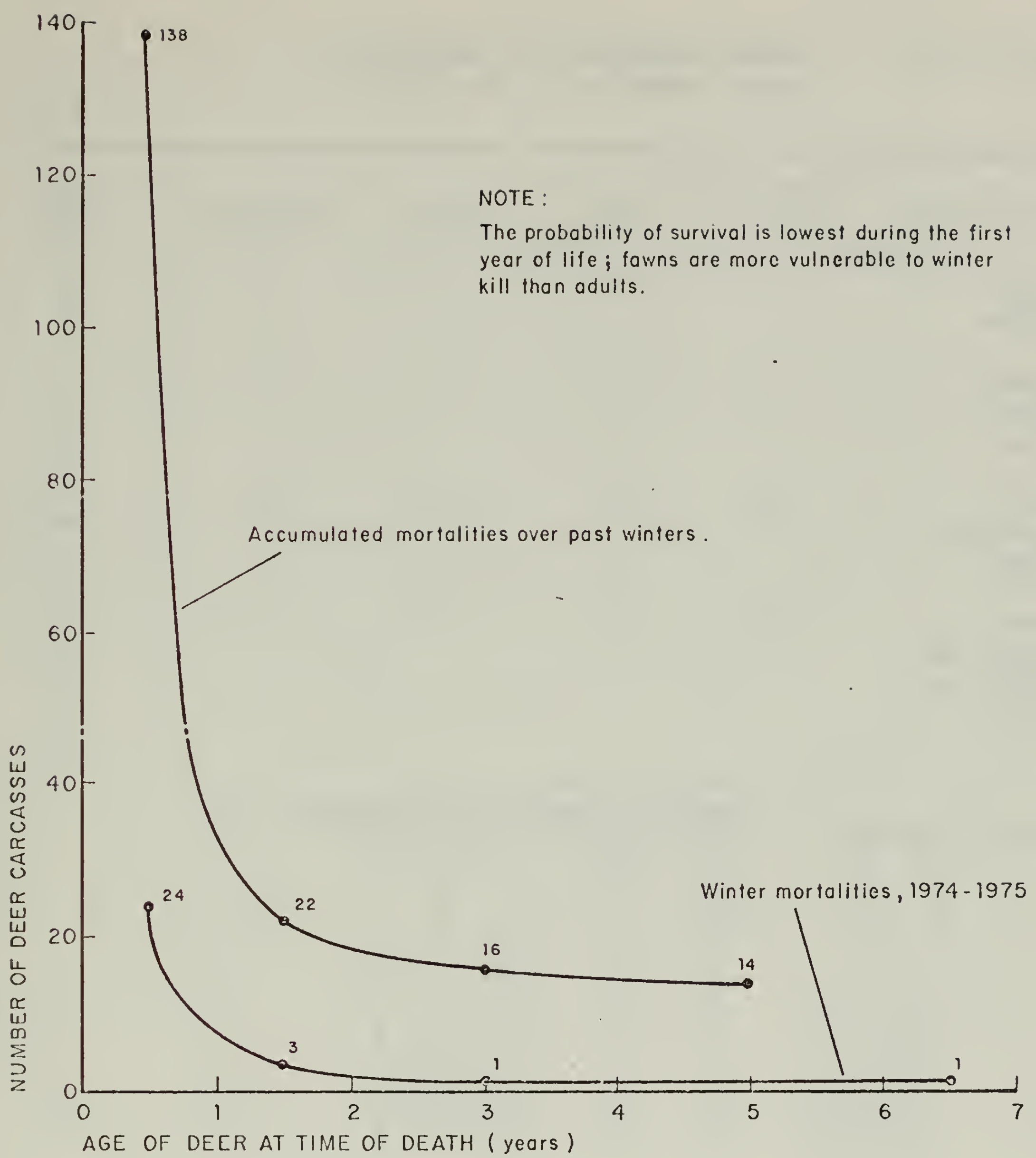
Preliminary work was begun on determination of average litter size and reproductive cycles. Results indicate an average of 5.0 embryos implanted for Peromyscus maniculatus, the deer mouse, and 5.6 embryos for Eutamias minimus, the least chipmunk.

The frequency of food items in the diets of the most abundant rodent species was determined. See Table II D-4. The deer mouse relied heavily on arthropods for food in May and June and consumed lesser amounts of arthropods in July and August. The remainder of the deer mouse diet consisted of vegetation. The least chipmunk consumed vegetation and arthropods in approximately equal amounts. Their intake of seeds was minimal in May, June, and July, but was somewhat higher in August for the chipmunk. Both species appear to be opportunistic feeders.

Table II D-1 DISTRIBUTION OF DEER CARCASSES[1] IN FIVE HABITAT TYPES ON TRACT C-b[2]

Habitat Type	Number of Carcasses Found (No./acre)	Number of Carcasses Expected If Randomly Distributed	Number of Acres in Each Habitat
Pinyon-juniper	22 (0.3)	46	79
Chained pinyon-juniper	7 (0.1)	46	79
Valley sagebrush	17 (0.4)	23	40
Lower valleys	77 (1.0)	46	79
Small draws	48 (2.7)	10	18

1. Carcasses are not randomly distributed (chi^2 = 204; df = 4; P <.001).
2. Total area sampled = 119.25 hectares (295 acres).



WOODWARD - CLYDE CONSULTANTS

Figure II D-1
Deer Mortality on
Tract C-b.

DATE	5 SEP 1975
PROJ. NO.	74-669
DRAFTED	W. W.
APP'D	J.M.

Table II D-2 PERCENT FREQUENCY[a] OF TRACKS FROM COUNTS CONDUCTED 14 JULY 1975.

Habitat Type	No. of Quadrats	Deer	Coyote	Cottontail	Other
Pinyon-juniper	19	0	0	31.6	0
Chained pinyon-juniper	19	0	0	0	0
Upper sagebrush valleys	19	0	15.8	73.7	5.3 (bobcat)
Lower valleys and agricultural meadows	18	0	5.5	11.1	0

[a]Percent frequency = $\frac{\text{number of quadrats with tracks}}{\text{total number of quadrats}} \times 100$

Table II D-3 SMALL MAMMALS PRESENT ON TRACT C-b IN JUNE AND JULY 1975

Scientific Name	Common Name	June 1975			July 1975		
		Satellites	Site 1	Site 2	Satellites	Site 1	Site 2
LAGOMORPHA							
Leporidae							
Sylvilagus sp.	Cottontail rabbit	x					
RODENTIA							
Sciuridae							
Citellus lateralis	Golden-mantled ground squirrel	x	x		x	x	x
Citellus richardsoni	Richardson's ground squirrel	x					
Eutamias minimus	Least chipmunk	x	x	x	x	x	x
Eutamias quadrivittatus	Colorado chipmunk	x		x	x		x
Geomyidae							
Thomomys talpoides	Northern pocket gopher		x				
Heteromyidae							
Perognathus apache	Apache pocket mouse	x	x		x		
Cricetidae							
Microtus montanus	Montane vole		x			x	
Microtus sp.	Vole	x			x		
Neotoma cinerea	Bushy-tailed wood rat				x		
Peromyscus maniculatus	Deer mouse	x	x	x	x	x	x
Zapus princeps	Western jumping mouse	x					
CARNIVORA							
Mustelidae							
Mustela erminea	Ermine	x					

Table II D-4 RELATIVE FREQUENCIES OF SMALL MAMMAL DIET ITEMS FOR MAY, JUNE, JULY AND AUGUST 1975

Species / Diet Item	May		June		July		August	
	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2
Peromyscus maniculatus								
Vegetation	19.2%	22.2%	31.7%	21.2%	50.0%	55.7%	47.2%	39.4%
Insect	79.1%	75.9%	68.3%	78.8%	50.0%	40.5%	50.9%	60.6%
Seed	1.7%	1.9%	0	0	0	3.8%	1.9%	0
Stomachs Examined	6	4	3	4	1	2	3	4
Eutamias minimus								
Vegetation	50.7%	66.2%	67.9%	61.1%	30.9%	-	56.9%	63.4%
Insect	48.6%	33.8%	32.1%	38.9%	69.1%	-	33.9%	27.2%
Seed	0.7%	0	0	0	0	-	9.2%	9.4%
Stomachs Examined	3	2	1	1	2	-	7	5

Birds

Censuses of avian communities on Tract C-b occurred between May 26 and June 2, 1975 and between July 11 and July 12, 1975. The major objective was to obtain information on the nesting bird populations within principal tract habitats.

During the late May and early June investigations, censusing was accomplished by Emlen strip procedures along the eight standard avian transects. During July, Emlen strip procedures were employed in four habitats. Data from these censuses were used to provide estimates of relative abundance of songbird species utilizing habitats on or close to Tract C-b. Of the 49 summer residents recorded on the transects during both series of censuses, 24 species had not been recorded in previous censuses on the Tract. Thirteen species noted during these censuses had also been recorded during fall, winter, and spring seasons.

Waterfowl observations at the two impoundments documented the presence of nine species in May and June and six species during July. Species diversity was numerically dominated by the mallard, green-winged teal, and spotted sandpiper during both investigative periods. The cinnamon teal, American coot, and Wilson's phalarope were also observed during May, June, and July, while the pied-billed grebe, common snipe, and blue-winged teal were seen in May and June.

Qualitative observations made throughout tract habitats verified the presence of an additional 25 species. The most frequently encountered breeding species in the study area were mountain bluebirds, chipping sparrows, vesper sparrows, red-winged blackbirds, Brewer's sparrows, and yellow-rumped warblers. Violet-green, rough-winged, and cliff swallows were also very common. Two species considered unusual in northwestern Colorado, the red-eyed vireo and bobolink, were recorded.

Eleven passerine nests were encountered during the reporting period. The nesting species were black-billed magpies, red-winged blackbirds, Brewer's blackbirds, starlings, Say's phoebes, and blue-gray gnatcatchers.

The common raven, red-tailed hawk, turkey vulture, and great horned owl were the most frequently observed raptors. The American kestrel, golden eagle, goshawk, and Cooper's hawk were the other diurnal species noted, while the screech owl and saw-whet owl comprised the other nocturnal species recorded. The saw-whet owl had not been previously observed on the Tract.

No additional raptor nest sites were discovered during the late spring and summer census periods. All active raptor nests previously encountered on the Tract were described in the Quarterly Data Report #3. One-hundred fourteen raptor pellets were collected from active nesting sites and roosting stations during May and analyzed. Pellets were predominantly from great horned owls; pellet analysis proved that microtines (voles) were the owl's major prey, comprising 79.5% of 478 prey species identified.

Because of the relatively low amount of raptor activity observed on the Tract during summer, the July pellet collections were postponed until September.

Seventy-six species were tallied during field census activities conducted during May, June and July, 1975. A total of 117 bird species have been documented since the initiating of field sampling in early October, 1974 (Table II D-5).

Amphibians and Reptiles

During the first year of study of Tract C-b, six reptiles and two amphibians were observed. The reptiles included two snakes and four lizards. The tiger salamander, an amphibian, was collected for the first time during June. Lizards represent the most abundant group and Sceloporus graciosus, the sagebrush lizard, was the most abundant lizard observed at both small mammal trapping grids.

Arthropods

Arthropods representing three classes, 15 orders and 70 familes were identified from collections on Tract C-b during May-July, 1975. Analysis of data from pit-can traps indicates that the chained pinyon-juniper and pinyon-juniper vegetation support equally diverse arthropod faunal assemblages. The relative abundance was not found to vary greatly with the species of shrub sampled by sweep netting. Of those species collected in the period May-July, 1975, 43% are classified as herbivores, 36% predators, 4% omnivores, 10% scavengers, and 7% parasites. Periods of peak activity could not be discerned for the majority of arthropods collected during each survey period. Lepidoptera larvae were particularly abundant during the months of May and June, 1975. Food habit studies show that small rodents consumed large quantities of these larvae.

II D-2 Aquatic Studies

The aquatic studies for this quarter included fish, benthos, periphyton, primary productivity, sediment analysis, and water quality. Locations and descriptions of sampling stations are included in the data report.

Fish

Fish were collected in July; however, high flows prevented sampling for fish in the White River. Species of fish collected included those caught in previous surveys (Table II D-6). Mountain suckers and speckled dace were in spawning condition in July.

Stomach analyses indicated brook trout had fed primarily on aquatic insects, with dipterons being the most abundant food (Table II D-7). Mountain suckers had been feeding on algae and some insects (Table II D-8).

Table II D-5 SPECIES OF BIRDS OBSERVED ON TRACT C-b DURING FALL, WINTER, SPRING, AND SUMMER OF THE FIRST YEAR'S INVESTIGATION

ORDER FAMILY Species	Common Name	Season of Observation Fall	 Winter	 Spring	 Summer
ANSERIFORMES (Screamers, Swans, Geese and Ducks)					
ANATIDAE (Swans, Geese and Ducks)					
Anas platyrhynchos	Mallard	x	x	x	x
Anas strepera	Gadwall	x	x		
Anas crecca	Green-winged teal	x	x	x	x
Anas discors	Blue-winged teal	x			x
Anas americana	American wigeon	x	x	x	
Anas clypeata	Northern shoveler	x			
Anas cyanoptera	Cinnamon teal			x	x
Aix sponsa	Wood duck			x	
Bucephala clangula	Common goldeneye		x	x	
Bucephala islandica	Barrow's goldeneye		x		
Bucephala albeola	Bufflehead		x		
Mergus serrator	Red-breasted merganser		x		
FALCONIFORMES (Vultures, Hawks and Falcons)					
CATHARTIDAE (Vultures)					
Cathartes aura	Turkey vulture			x	x

Table II D-5 (continued)

ORDER FAMILY Species	Common Name	Season of Observation Fall	Winter	Spring	Summer
FALCONIFORMES (Cont.)					
ACCIPITRIDAE (Kites, Hawks and Eagles)					
Accipiter gentilis	Goshawk				x
Accipiter cooperii	Cooper's hawk				x
Circus cyaneus	Marsh hawk	x			
Buteo lagopus	Rough-legged hawk	x	x	x	
Buteo jamaicensis	Red-tailed hawk	x		x	x
Aquila chrysaetos	Golden eagle	x	x	x	x
Haliaeetus leucocephalus	Bald eagle			x	
FALCONIDAE (Caracaras and Falcons)					
Falco sparverius	American kestrel	x	x	x	x
GRUIFORMES (Cranes and Allies)					
RALLIDAE (Rails, Gallinules and Coots)					
Fulica americana	American coot	x			x
CHARADRIFORMES (Shorebirds, Gulls, Auks and Allies)					
CHARADRIIDAE (Plovers, Turnstones and Surfbirds)					
Charadrius vociferus	Killdeer			x	

Table II D-5 (continued)

ORDER FAMILY Species	Common Name	Season of Observation Fall	Winter	Spring	Summer
CHARADRIFORMES (Cont.)					
SCOLOPACIDAE					
Tringa solitaria	Solitary sandpiper				x
Capella gallinago	Common snipe		x	x	x
PHALAROPODIDAE (Phalaropes)					
Steganopus tricolor	Wilson's phalarope				x
COLUMBIFORMES (Sand-grouse, Pigeons and Doves)					
COLUMBIDAE (Pigeons and Doves)					
Zenaidura macroura	Mourning dove	x		x	x
STRIGIFORMES (Owls)					
TYTONIDAE (Barn Owls)					
Tyto alba	Barn owl	x			
STRIGIDAE (Typical owls)					
Otus asio	Screech owl	x			x
Bubo virginianus	Great horned owl	x	x	x	x
Asio otus	Long-eared owl	x			
Nyctea scandiaca	Snowy owl		x		
Aegolius acadicus	Saw-whet owl				x

Table II D-5 (continued)

ORDER FAMILY Species	Common Name	Season of Observation Fall	 Winter	 Spring	 Summer
CAPRIMULGIFORMES (Goatsuckers, Oilbirds and Allies)					
CAPRIMULGIDAE (Goatsuckers)					
<u>Phalaenoptilus nuttalli</u>	Poor-will				x
<u>Chordeiles minor</u>	Common nighthawk				x
APODIFORMES (Swifts and Hummingbirds)					
APODIDAE (Swifts)					
<u>Aeronautes saxatalis</u>	White-throated swift				x
TROCHILIDAE (Hummingbirds)					
<u>Selasphorus platycercus</u>	Broad-tailed hummingbird				x
CORACIIFORMES (Kingfishers, Motmots, Rollers, Bee-eaters and Hornbills)					
ALCEDINIDAE (Kingfishers)					
<u>Megaceryle alcyon</u>	Belted kingfisher			x	
PICIFORMES (Woodpeckers, Jacamars, Toucans and Barbets)					
PICIDAE (Woodpeckers and Wrynecks)					
<u>Colaptes auratus</u>	Common flicker	x	x	x	x
<u>Sphyrapicus thyroideus</u>	Williamson's sapsucker				x
<u>Dendrocopos villosus</u>	Hairy woodpecker	x			
<u>Dendrocopos pubescens</u>	Downy woodpecker		x		

Table II D-5 (continued)

ORDER FAMILY Species	Common Name	Season of Observation Fall	 Winter	 Spring	 Summer
PASSERIFORMES (Perching birds)					
TYRANNIDAE (Tyrant flycatchers)					
Myiarchus cinerascens	Ash-throated flycatcher				x
Sayornis saya	Say's phoebe			x	x
Epidonax wrightii	Gray flycatcher				x
Epidonax difficilis	Western flycatcher	x			
Contopus sordidulus	Western wood pewee			x	x
Nuttallornis borealis	Olive-sided flycatcher				x
ALAUDIDAE (Larks)					
Alauda arvensis	Horned lark	x	x		x
HIRUNDINIDAE (Swallows)					
Hirundo rustica	Barn swallow	x			x
Petrochelidon pyrrhonota	Cliff swallow	x			x
Tachycineta thalassina	Violet-green swallow				x
Iridoprocne bicolor	Tree swallow				x
Stelgidopteryx ruficollis	Rough-winged swallow				x

Table II D-5 (continued)

ORDER FAMILY Species	Common Name	Season of Observation Fall	 Winter	 Spring	 Summer
PASSERIFORMES (Cont.)					
CORVIDAE (Jays, Magpies and Crows)					
Cyanocitta stelleri	Steller's jay	x	x		
Aphelocoma coerulescens	Scrub jay	x		x	x
Gymnorhinus cyanocephalus	Pinyon jay	x	x	x	
Pica pica	Black-billed magpie	x	x	x	x
Nucifraga columbiana	Clark's nutcracker	x	x	x	x
Corvus corax	Common raven	x	x	x	x
Corvus brachyrhynchos	Common crow	x			
PARIDAE (Chickadees, Titmice, Verdins and Bushtits)					
Parus atricapillus	Black-capped chickadee	x	x		
Parus gambeli	Mountain chickadee	x	x	x	x
Parus inornatus	Plain titmouse			x	
SITTIDAE (Nuthatches)					
Sitta carolinensis	White-breasted nuthatch	x	x		
Sitta canadensis	Red-breasted nuthatch	x	x		

Table II D-5 (continued)

ORDER FAMILY Species	Common Name	Season of Observation Fall	Winter	Spring	Summer
PASSERIFORMES (Cont.)					
TROGLODYTIDAE (Wrens)					
Troglodytes aedon	House wren	x			x
Salpinctes obsoletus	Rockwren	x			x
Catherpes mexicanus	Canyon wren	x		x	
MIMIDAE (Mockingbirds and Thrashers)					
Sporeoscoptes montanus	Sage thrasher	x			
TURDIDAE (Thrushes, Solitaires and Bluebirds)					
Turdus migratorius	Robin	x	x	x	x
Myadestes townsendii	Townsend's solitaire	x	x		x
Hylocichla guttata	Hermit thrush				x
Sialia currucoides	Mountain bluebird	x		x	x
SYLVIIDAE (Gnatcatchers and Kinglets)					
Polioptila caerulea	Blue-gray gantcatcher				x
Regulus calendula	Ruby-crowned kinglet	x			

Table II D-5 (continued)

ORDER FAMILY Species	Common Name	Season of Observation Fall	Winter	Spring	Summer
PASSERIFORMES (Cont.)					
LANIIDAE (Shrikes)					
Lanius excubitor	Northern shrike	x	x	x	
Lanius ludovicianus	Loggerhead shrike			x	
STURNIDAE (Starlings)					
Sturnus vulgaris	Starling	x		x	
VIREONIDAE (Vireos)					
Vireo solitarius	Solitary vireo				x
Vireo olivaceus	Red-eyed vireo				x
Vireo gilvus	Warbling vireo				x
PARULIDAE (Wood warblers)					
Mniotilta varia	Black-and-white warbler				x
Vermivora ruficapilla	Orange-crowned warbler				x
Vermivora virginiae	Virginia's warbler				x
Dendroica petechia	Yellow warbler				x
Dendroica coronata	Yellow-rumped warbler	x			x
Dendroica nigrescens	Black-throated gray warbler				x
Geothlypis trichas	Common yellowthroat				x
Oporornis tolmiei	MacGillvray's warbler				x
Wilsonia pusilla	Wilson's warbler				x

Table II D-5 (continued)

ORDER FAMILY Species	Common Name	Season of Observation Fall	 Winter	 Spring	 Summer
PASSERIFORMES (Cont.)					
ICTERIDAE (Blackbirds and Orioles)					
Dolichonyx oryzivorus	Bobolink				x
Sturnella neglecta	Western meadowlark	x		x	x
Agelaius phoeniceus	Red-winged blackbird	x		x	x
Euphagus cyanocephalus	Brewer's blackbird	x			x
Molothrus ater	Brown-headed cowbird				x
THRAUPIDAE (Tanagers)					
Piranga ludoviciana	Western tanager				x
FRINGILLIDAE (Grosbeaks, Finches, Sparrows, and Buntings)					
Pheucticus melanocephalus	Black-headed grosbeak				x
Carpodacus mexicanus	House finch	x			x
Leucosticte tephrocotis	Gray-crowned rosyfinch		x		
Leucosticte atrata	Black rosy finch		x		
Leucosticte austcalis	Brown-capped rosy finch		x		
Spinus pinus	Pine siskin	x			x
Spinus tristis	American goldfinch	x			
Chlorura chlorura	Green-tailed towhee				x

Table II D-5 (continued)

ORDER FAMILY Species	Common Name	Season of Observation Fall	 Winter	 Spring	 Summer
PASSERIFORMES (Cont.)					
FRINGILLIDAE (Cont.)					
Pipilo erythrophthalmus	Rufous-sided towhee				x
Passerculus sandwichensis	Savannah sparrow	x			
Calamospiza melanocorys	Lark bunting				x
Pooecetes gramineus	Vesper sparrow	x			x
Amphispiza belli	Sage sparrow				x
Junco hyemalo	Dark-eyed junco		x	x	
Junco caniceps	Gray-headed junco	x	x	x	x
Spizella arborea	Tree sparrow	x	x	x	
Spizella passerina	Chipping sparrow				x
Spizella breweri	Brewer's sparrow				x
Zonotrichia leucophrys	White-crowned swallow	x			x
Melospiza melodia	Song sparrow	x	x	x	x

Table II D-6 NUMERICAL ABUNDANCE OF SPECIES OF FISH CAPTURED DURING JULY 1975 IN PICEANCE AND STEWART CREEKS

Station	Species: Brook trout	Rainbow trout	Mountain sucker	Speckled dace	Total
P-0			57	3	60
P-1	2		42	35	79
P-2	1		2		3
P-3	7		24	14	45
P-5			4		4
P-5A		1	1		2
P-6			2		2
P-7				3	3
S-1	2				2
S-2	6				6
L.S.L.	7				7
Totals	25	1	132	55	213

Station Legend:

P1-7: Piceance Creek

S1-2: Stewart Creek

L.S.L.: Lower Stewart Lake

Species Legend:

Brook trout - *Salvelinus fontinalis*

Rainbow trout -*Salmo gairdneri*

Mountain sucker -*Catostomus platyrhynchus*

Speckled dace - *Rhinichthys osculus*

Table II D-7 FOOD[1] OF BROOK TROUT COLLECTED FROM LOWER STEWART LAKE, JULY 1975

Stomach Contents	Fish #1	Fish #2	Fish #3
	Sex / Length / wt.	Sex / Length / wt.	Sex / Length / wt.
	Female 139mm 34.5g.	Female 154mm 42g.	Male 183mm 85g.
Diptera			
Tipulidae	1 (1.5)		
Chironomidae	54 (90)	106 (54)	48 (44)
Simulidae		35 (18)	15 (14)
Tipulidae		1 (0.5)	2 (2)
Culicidae		4 (2)	24 (22)
Stratiomyiidae			
Odontomyia		3 (1.5)	3 (2)
Adults		3 (1.5)	
Ephemeroptera			
Baetidae			
Baetis	2 (3)	12 (6)	9 (8)
Adults			4 (3)
Coleoptera			
Hydraenidae	1 (1.5)		
Dytiscidae			
Agabinus		3 (1.5)	
Odonata			
Adults		1 (0.5)	
Tricoptera			
Hydropsychidae			
Hydropsyche			1 (1)
Amphipoda			
Gammaridae			
Gammarus		27 (14)	
Hemiptera			
Coreidae[2]		1 (0.5)	

Table II D-7 (continued)

Stomach Contents	Fish #1			Fish #2			Fish #3		
	Sex	Length	wt.	Sex	Length	wt.	Sex	Length	wt.
	Female	139mm	34.5g.	Female	154mm	42g.	Male	183mm	85g.
Oligochaeta								3 (2)	
Homoptera Cicadellidae (Leafhopper)		2 (3)			1 (0.5)			1 (1)	
Algae		(5)							
Total Insects		60			197			110	
Total Stomach Volume		0.2 ml.			1.4 ml.			1.8 ml.	

1. Number of individuals; percentage of contents in parentheses.

2. Terrestrial

Table II D-8 FOOD OF MOUNTAIN SUCKERS COLLECTED FROM PICEANCE CREEK (P-2) JANUARY 1975

Fish Number	Stomach Contents Baetidae (#)	Chironomidae (#)	Simulidae (#)	All insects (%)	Algae (%)	Volume of Contents
1.	3*	19	7	60%	40%	0.1 ml.
2.	-	21	12	50%	50%	0.2 ml.
3.	-	3	2	5%	95%	0.1 ml.
4.	4	17	9	75%	25%	0.1 ml.
5.	-	30	-	30%	70%	0.1 ml.
6.	-	1	2	5%	95%	0.1 ml.
7.	-	19	3	40%	60%	0.2 ml.
8.	-	1	-	99%	1%	<0.1 ml.
9.	-	12	2	15%	85%	0.1 ml.
10.	-	3	-	1%	99%	<0.1 ml.

* Baetis sp.

Scale analyses were completed and fish of several age groups were identified. Fecundity estimates were made for mountain suckers and speckled dace. Female mountain suckers of 129-134 mm in total length produced from 2671 to 4166 eggs per spawning season; speckled dace of 87 to 109 mm in length produced from 2696 to 6998 eggs per spawning season. Population estimates were made for several areas of Piceance Creek (Table II D-9).

Benthos

Benthic macroinvertebrates collected include the annelids, arthropods and molluscs. The arthropods were the most numerous and diverse, represented by 7 orders and 34 taxa.

Benthic invertebrates were generally more abundant at upstream stations, with the exception of oligochaetes. Most orders of invertebrates were present in increased numbers compared to spring samples. These shifts in abundance are attributed to seasonal changes which occur naturally.

Periphyton

Periphyton samples from May and July were analyzed for this report. Diatoms were the most abundant periphyton species. Green, blue-green algae and euglenids were also collected. Periphyton primary productivity estimates were made from ash-free weights (Table II D-10). The upstream and downstream stations in Piceance Creek had lower productivity estimates, with the highest values occurring at the station in between.

Phytoplankton Primary Productivity

Light and dark bottle analyses of primary production in the four lakes (Upper and Lower Stewart and Upper and Lower Willow), were made in July. Analysis of planktonic primary production showed that production is negligible (Table II D-11). A possible explanation for this might be related to the high intensity of light in the upper portions of these clear, high-bicarbonate waters. An effort will be made to place sampling bottles at a greater depth during the next sampling period to compensate for any inhibition of oxygen production by light near the surface.

Water Quality

In July, water samples were analyzed for common minerals and nutrients, total hardness, total alkalinity, total dissolved solids, bacteria, and pathogens. In addition, pH, temperature, dissolved oxygen and specific conductance were measured in the field. Temperatures in Piceance Creek ranged from 55°F to 58°F in July. Dissolved solids increased with diminished flow and ranged from 1300 to 2600 ppm, increasing downstream. Sodium and potassium levels increased significantly over May values;

Table II D-9 FISH POPULATION ESTIMATES FOR SELECTED PICEANCE CREEK STATIONS BASED ON SAMPLING IN JULY 1975

Replicate	Total Fish	Mountain Suckers	Brook Trout	Speckled Dace
Station P-1				
1	35	18	2	15
2	26	15	0	11
3	18	9	0	9
Totals	79	42	2	35

Regression Data:	
Correlation Coefficient	-0.99
Slope	-2.59
$\bar{Y}$	58.33
Std. Dev. Y	22.12
$\bar{X}$	26.33
Std. Dev. X	8.50
(Population Estimate) Intercept	126.65

Replicate	Total Fish	Mountain Suckers	Brook Trout	Speckled Dace
Station P-3				
1	25	13	4	8
2	11	7	1	3
3	9	4	2	3
Totals	45	24	7	14

Regression Data:	
Correlation Coefficient	-0.93
Slope	-1.07
$\bar{Y}$	35.33
Std. Dev. Y	10.01
$\bar{X}$	15.00
Std. Dev. X	8.71
(Population Estimate) Intercept	51.51

Table II D-10 PERIPHYTON PRODUCTIVITY ESTIMATES FOR PICEANCE BASIN STATIONS, JULY 1975

Station No.	Ash Free Weight (gram)	Productivity (gm ash free wt/day/m^2)
P-1	.0088	.1136
P-2	.0031	.0400
P-2	.0045	.0581
P-2	.0122	.1576
P-3	.0091	.1175
P-3	.0122	.1576
P-3	.0119	.1537
P-5	.0166	.2144
P-5	.0228	.2945
P-5	.0281	.3630
P-6	.0010	.0129
P-6	.0027	.0348
P-6	.0023	.0297
P-7	.0048	.0620
P-7	.0022	.0284
P-7	.0040	.0516
S-1	.0023	.0283
S-1	.0019	.0233
S-1	.0025	.0307
S-2	.0060	.0704
S-2	.0063	.0739
S-2	.0058	.0681
USL	.0021	.0258
USL	.0017	.0209
USL	.0031	.0381

Table II D-10 (continued)

Station No.	Ash Free Weight (gram)	Productivity (gm ash free wt/day/m^2)
LSL(H)*	.0000	0
LSL(H)*	.0036	.0465
LSL(H)*	.0029	.0374
LSL(V)*	.0017	.0219
LSL(V)*	.0009	.0116
LSL(V)*	.0006	.0077
W-1	.0058	.0681
W-1	.0068	.0798
W-1	.0173	.2031
W-3	.0360	.4433
W-3	.0034	.0418
W-3	.0030	.0369
UWL	.0035	.0452
UWL	.0034	.0439
UWL	.0021	.0271

Station Legend:

P1-7 Piceance Creek
S1-2 Stewart Creek
USL,LSL Upper, Lower Stewart Lake
W1-3 Willow Creek
UWL Upper Willow Lake

* (V) Vertically positioned substrate (slide)
(H) Horizontally positioned substrate (slide)

Table II D-11 LIGHT AND DARK BOTTLE DISSOLVED OXYGEN DETERMINATIONS[1] FOR UPPER AND LOWER WILLOW AND STEWART LAKES, JULY 1975

Station & Replicate	Time of Exposure	Temp.	Light Bottle D.O. (mg/L)	Dark Bottle D.O. (mg/L)	D.O. Sample From Lake[2] (mg/L)
U.S.L.					
	1. Initial	61°F			8.96
	2. Initial	61°F			8.82
	1. 8 Hrs.	61°F	8.96	8.82	
	2. 8 Hrs.	61°F	9.38	8.54	
	1. 24 Hrs.	61°F	8.68	8.68	
	2. 24 Hrs.	61°F	8.96	8.96	
L.S.L.					
	1. Initial	55°F			4.62
	2. Initial	55°F			4.55
	1. 8 Hrs.	55°F	4.76	4.76	
	2. 8 Hrs.	55°F	4.62	3.50	
	1. 24 Hrs.	55°F	4.90	4.62	
	2. 24 Hrs.	55°F	4.90	4.76	
U.W.L.					
	1. Initial	50°F			7.28
	2. Initial	50°F			8.26
	1. 8 Hrs.	50°F	7.70	7.70	
	2. 8 Hrs.	50°F	7.28	-	
	1. 24 Hrs.	50°F	7.42	6.44	
	2. 24 Hrs.	50°F	7.70	6.86	
L.W.L.					
	1. Initial	53°F			3.99
	2. Initial	53°F			3.50

Table II D-11 (continued)

Station & Replicate	Time of Exposure	Temp.	Light Bottle D.O. (mg/L)	Dark Bottle D.O. (mg/L)	D.O. Sample From Lake[2] (mg/L)
L.W.L. (cont)					
	1. 8 Hrs.	53°F	4.06	3.50	
	2. 8 Hrs.	53°F	4.34	-	
	1. 24 Hrs.	53°F	4.20	3.36	
	2. 24 Hrs.	53°F	4.06	-	

Station Legend:

U.S.L. - Upper Stewart Lake
L.S.L. - Lower Stewart Lake
U.W.L. - Upper Willow Lake
L.W.L. - Lower Willow Lake

1. Computed by Modified Winkler Method.
2. Taken when light and dark bottles were placed in the lake.

cattle grazing diminished in July, resulting in these lower levels at lower altitudes. No pathogenic bacteria were identified in samples during the quarter.

Sediment Analyses

Sediment samples were collected from all stations and analyzed for total Kjeldahl nitrogen and chemical oxygen demand. A spectrographic screen was run for heavy metals on selected samples. No heavy metals were detected in amounts above permissible standards (Table II D-12). Sediment grain-size analyses were conducted for all stations. Silt and fine sediment levels were diminished in July compared with May samples.

II D-3 Terrestrial Vegetation Studies

Flora

The collection of field data has been emphasized during the fourth quarter and these data are currently being analyzed. Sixty species not previously reported for the Tract were collected during the 1975 field season. Numerous collections of mosses, lichens, and fungi have been made but have not yet been identified.

Vegetation Mapping and Additional Sampling Program

The vegetation map has been completed; fourteen cover types have been used to characterize the vegetation (Table II D-13 and Figure II D-2). Seventeen additional vegetation sites have been sampled. These communities correspond directly to the mapped vegetation units and will be used for preparing descriptions of the plant communities.

Intensive Study Sites

Initial collection of baseline for each site has been completed. Frequency data for all herbaceous species, and density, cover, and frequency data for trees and shrubs have been gathered and will be analyzed in the next report.

Productivity Studies

Clipping of 0.1 m^2 quadrats has been conducted at monthly intervals throughout the growing season (May - August) to calculate herbaceous productivity. Shrub productivity clippings were made in April and will be taken again in September. Again, analysis will be completed in the next report.

Table II D-12 HEAVY METAL SPECTROGRAPHIC SCREEN ANALYSIS FOR SELECTED SEDIMENT SAMPLES FROM PICEANCE BASIN, JULY 1975

	Stations			
Metals	P-1	P-7	LSL	LWL
Silicon	7.10%	7.20%	6.55%	6.10%
Manganese	0.28	0.30	0.18	0.15
Chromium	0.035	0.025	0.050	0.020
Nickel	0.010	0.005	0.010	0.008
Boron	0.020	0.015	0.010	0.015
Lead	0.005	0.001	0.003	0.005
Magnesium	0.003	0.010	0.005	0.005
Copper	0.015	0.015	0.025	0.010
Titanium	0.015	0.010	0.020	0.020
Aluminum	2.85	3.50	3.10	2.58
Potassium	0.020	0.015	0.010	0.015
Calcium	0.43	0.55	0.35	0.30
Sodium	0.080	0.085	0.080	0.075
Iron	Remainder	Remainder	Remainder	Remainder

Station Legend

P-1, P-7 - Piceance Creek

L.S.L. - Lower Stewart Lake

L.W.L. - Lower Willow Lake

Table II D-13 VEGETATION COVER TYPES PORTRAYED ON THE TRACT C-b VEGETATION MAP

Douglas-fir Forest

Pinyon-Juniper Woodland

Chained Pinyon-Juniper Rangeland

Mixed Mountain Shrub Community

Big Sagebrush Community

Greasewood Community

Rabbitbrush Community

Bunchgrass Community

Great Basin Wild Rye Community

Riparian Community

Marsh

Annual Weed Community

Agricultural Area

Pond

OIL SHALE TRACT C-b
ENVIRONMENTAL AND EXPLORATION ACTIVITIES

VEGETATION MAP

FIGURE II D-2

Phenology and Shrub Growth

Observations on phenological development of selected herbaceous species have been collected at least monthly throughout the season. Measurements of marked twigs on shrubs were made during June and will again be made in September.

Decomposition and Litter Accumulation

Litter trap and decomposition studies are progressing. Litter collected in July is currently being dried and weighed. Additional collections of litter will be made when decomposition bags are retrieved in October.

II D-4 Dendrochronology and Dendroclimatology

The Dendroclimatology and Dendrochronology Studies were completed during the third quarter. The final report on these studies was submitted in Quarterly Data Report #3 and summarized in Summary Report #3. No further studies are anticipated in this area.

II D-5 Soil Survey

During the 4th quarter, 36 soil samples were collected from 10 areas designated by the Soil Conservation Service (SCS) as representative types of the soil series occurring on Tract C-b and the surrounding one mile study area. The samples were obtained in each horizon from each of the following soil series:

1. Glendive Fine Sandy Loam
2. Piceance Fine Sandy Loam
3. Redcreek-Rentsac Complex
4. Rentsac Channery
5. Forelle Loam
6. Hagga Loam
7. Hanly Loam

Table II D-14 indicates the classification of these soil series.

Physical and chemical descriptions of the series will be identified in the Quarterly Data Report #5. Narrative descriptions of the physical characteristics of the series have been furnished by the SCS. The chemical analysis of soils (see Quarterly Data Report #4 for details) is currently being completed. A soil map accompanies these data.

TABLE II D-14

SOILS OF LEASE TRACT C-b STUDY AREA

(USDA Soil Classification System, 1960)

ORDER	SUBORDER	GREAT GROUP	SUBGROUP	FAMILY	SERIES
ARIDISOLS	Argid	Haplargids	Borallic	Fine Loamy Mixed	Forelle Loam
	Orthids	Camborthids	Borallic	Fine Loamy Mixed	Piceance Fine Sandy Loam
ENTISOLS	Fluvents	Torrifluvents	Ustic	Coarse Loamy Mixed (Cal.) Frigid	Glendive Fine Sandy Loam
			Ustic	Sandy Mixed Frigid	Hanly Loam
			Typic	Fine Loamy Mixed (Cal.) Frigid	Hagga Loam
	Orthents	Torriorthents	Lithic-Ustic	Loamy Mixed (Cal.) Frigid	Redcreek-Rentsac Complex
			Lithic-Ustic	Loamy Skeletal (Cal.) Frigid	Rentsac Channery

Key to Suffixes and Prefixes: Arid = dry; Arg = Clayey; Hapl = minimum horizon; Bor = cool, high organic; Orth = typical; Camb = altered; Ent = recent; Fluv = deposited by water; Torri = dry, low organic; Ust = dry, summer rains; Typ = typical; Lith = rocky

Other Terminology: Cal. = calcareous; Skeletal = interspersed with rock; Channery = containing fine pieces of sandstone or shale

III A FISH AND WILDLIFE MANAGEMENT PLAN

During this quarter, work has continued on the preparation of a procedural Fish and Wildlife Managment Plan for submission with the Detailed Development Plan. Through intensive interaction with consultants who have been working on the Environmental Baseline Studies, and through analysis of the data collected in those studies, the following major topics are to be included in the Plan:

1. Goals of the Plan. A statement of the goals of the Fish and Wildlife Management Plan, which include meeting the requirements of the Oil Shale Lease Environmental Stipulations;

2. Scope of the Plan. General statements regarding the areal coverage of the Plan, phases covered, envisioned interaction with agencies involved in traditional management in the Piceance Basin area, and procedures for cooperating with these agencies;

3. Existing Wildlife and Habitats. A section covering a general discussion of wildlife habitat types as they have been identified to date in the Tract area, and wildlife species which have been identified in this area, or could be expected to occur in the area. Ecological relationships such as the terrestrial food web, predator-prey relationships, migratory patterns of mule deer and raptors, and determination of "important" species for the purposes of the Plan are also included;

4. Operational Setting. A section covering the planned location of facilities and planned scheduling of development activities. Also included are indications of specific types of impacts which might be expected to occur as a result of each type of activity planned for each phase of development; and

5. Implementation Plan. Concerned with the general strategy of the Plan, recommended design, and specific problem areas. Included are definition of problems envisioned, timing of expected problems, proposed accomplishments with respect to minimizing the effects of these problems, details on strategies and tactics, and performance standards. Types of specific problem areas include the following: significant modification of terrestrial habitats;

erosion in terrestrial habitats; modification of aquatic habitats; water pollution affecting aquatic habitats; reduction in ground-water discharge affecting terrestrial habitats; wildlife harassment resulting from extra vehicular and human activity and from activities of companion animals; impacts resulting from air pollution; impacts resulting from noise; vehicle-wildlife collisions; secondary impacts resulting from growth in human population; personnel management; access management; and contingency planning problems.

III B REVEGETATION PROGRAM

During the fourth quarter, generalized procedures for the revegetation of areas disturbed during the exploration phase on Tract C-b were finalized. The specific plans to be used for each individual revegetation site were prepared from these general specifications and submitted to the Area Oil Shale Supervisor for approval. The specific plans have been approved and will be implemented during October and November of this year. The preparation of sites for seeding is currently underway.

Tables III B-1 and III B-2 are intended as informative summaries of the specific planting plans to be implemented this fall on Tract C-b.

TABLE III B-1

SITE PLANTING PLAN	Air Quality-Met. Tower, Chained Pinyon-Juniper	A-1, Valley Bottom Sage-brush, near main turnoff on Piceance Creek Road	A-2, Valley Bottom Sage-brush, Pasture	A-3, Valley Bottom Sage-brush, In Scandard Gulch	A-4, Valley Bottom Sage-brush, head of Scandard Gulch	A-5, Valley Bottom Sage-brush, on Piceance Creek at mouth of Cottonwood Gulch	A-6/SG20, Valley Bottom sagebrush, on Piceance Creek Road, big cut in hillside next to it	A-7/SG19, Valley Bottom sagebrush, on Piceance Creek at mouth of Sorghum Gulch
Species	lbs./acre	lbs./acre	lbs./acre	lbs./acre	lbs./acre	lbs./acre	lbs./acre	lbs./acre
Agropyran intermedium amur - Intermediate wheatgrass	2	3		3	3	2	2	2
Agropyron trichophorum Pubescent wheatgrass	2	3		3	3	3	3	3
Bromus marginatus Mountain brome								
Agropyron smithii rosano - Western wheatgrass	2	3		3	3	2	2	2
Agropyron trachycaulum Slender wheatgrass	1							
Cercocarpus montanus Mountain Mahogany	1/2							
Flymus cinereus Basin wildrye						1	1	1
Hedysarum boreale utah Sweetvetch	1/2	1/2		1/2	1/2	1/2	1/2	1/2
Koeleria gracilis June grass	2							
Oryzopsis hymenoides Indian ricegrass	1	1		1	1	1	1	1
Purshia tridentata Antelope bitterbrush	1/2	1/2		1/2	1/2	1	1	1
Stipa comata Green needlegrass	1	1		1	1	1/2	1/2	1/2
Symphoricarpus oreophilus Snowberry	1/2							
TOTAL	11½	12	0	12	12	11	11	11

TABLE III B-1 Cont.

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SITE / PLANTING / PLAN	A-8, Valley Bottom sage-brush, Lower Stewart Gulch	A-9/SC8, Valley Bottom sagebrush, near Oldland Summer Camp	A-10/SC14, Valley Bottom sagebrush, Middle Stewart Gulch	A-11, Valley Bottom sage-brush, West Stewart, just past turnoff to ridge to met-tower	A-12, Valley Bottom sage-brush, Upper West Stewart Gulch	A-13, Valley Bottom sage-brush, in wash at head of Sorghum Gulch	Cb2, Chained Pinyon-Juniper ridge East of Cottonwood Gulch	Cb4, Chained Pinyon-Juniper ridge West of West Stewart Gulch
Species	lbs./acre	lbs./acre	lbs./acre	lbs./acre	lbs./acre	lbs./acre	lbs./acre	lbs./acre
Agropyran intermedium amur - Intermediate wheatgrass	2	2	2	2	2	2	2	2
Agropyron trichophorum Pubescent wheatgrass	3	3	3	3	3	3	2	2
Bromus marginatus Mountain brome								
Agropyron smithii rosano - Western wheatgrass	2	2	2	2	2	2	2	2
Agropyron trachycaulum Slender wheatgrass							1	1
Cercocarpus montanus Mountain Mahogany							1/2	1/2
Elymus cinereus Basin wildrye	1	1	1	1	1	1		
Hedysarum boreale utah Sweetvetch	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
Koeleria gracilis June grass							2	2
Oryzopsis hymenoides Indian ricegrass	1	1	1	1	1	1	1	1
Purshia tridentata Antelope bitterbrush	1	1	1	1	1	1		
Stipa comata Green needlegrass	1/2	1/2	1/2	1/2	1/2	1/2		
Symphoricarpus oreophilus Snowberry							1/2	1/2
TOTAL	11	11	11	11	11	11	11½	11½

TABLE III B-1 Cont.

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SITE PLANTING PLAN Species	N04, Chained Pinyon-Juniper, ridge West of Scandard Gulch	N07/SG-7, Chained Pinyon-Juniper, ridge West of West Stewart Gulch	N012/SG12, Chained Pinyon-Juniper, ridge East of Sorghum Gulch	SG1, Valley Bottom [illegible] brush, mouth of Scandard Gulch	SG2, Chained Pinyon-Juniper, ridge West of Cottonwood Gulch	SG3, Chained Pinyon-Juniper, ridge East of Sorghum Gulch	SG4, Chained Pinyon-Juniper, ridge between Scancard and Little Scandard Gulches	SG5, Chained Pinyon-Juniper West of support facility
	lbs./acre	lbs./acre	lbs./acre	lbs./acre	lbs./acre	lbs./acre	lbs./acre	lbs./acre
Agropyran intermedium amur - Intermediate wheatgrass	2	2	2	3	2	2	2	2
Agropyron sibircum Siberian wheatgrass	2	2	2	3	2	2	2	2
Bromus marginatus Mountain brome								
Agropyron smithii rosano - Western wheatgrass	2	2	2	3	2	2	2	2
Agropyron trachycaulum Slender wheatgrass	1	1	1		1	1	1	1
Cercocarpus montanus Mountain Mahogany	1/2	1/2	1/2		1/2	1/2	1/2	1/2
Elymus cinereus Basin wildrye								
Hedysarum boreale utah Sweetvetch	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
Koeleria gracilis June grass	2	2	2		2	2	2	2
Oryzopsis hymedoides Indian ricegrass	1	1	1	1	1	1	1	1
Purshia tridentata Antelope bitterbrush				1/2				
Stipa comata Green needlegrass				1				
Symphoricarpus oreophilus Snowberry	1/2	1/2	1/2		1/2	1/2	1/2	1/2
TOTAL	11½	11½	11½	12	11½	11½	11½	11½

TABLE III B-1 Cont.

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SITE PLANTING PLAN	SG6, Chained Pinyon-Juniper, ridge West of Sorghum Gulch	SG-7/SQ7, Chained Pinyon-Juniper, ridge West of West Stewart Gulch	SG8/A9, Valley bottom Sage-brush, near Oldland Summer Camp	SG9, Chained Pinyon-Juniper, ridge above Scandard Gulch	SG10, Plateau sage/Chained Pinyon-Juniper, near met.-tower	SG11, Chained Pinyon-Juniper, ridge East of Sorghum Gulch	SG12/SQ12, Chained Pinyon-Juniper, ridge East of Sorghum Gulch	SG13, Chained Pinyon-Juniper, lower ridge West of West Stewart Gulch
Species	lbs./acre	lbs./acre	lbs./acre	lbs./acre	lbs./acre	lbs./acre	lbs./acre	lbs./acre
Agropyran intermedium amur - Intermediate wheatgrass	2	2	2	2	2	2	2	2
Agropyron sibircum Siberian wheatgrass	2	2	3	2	2	2	2	2
Bromus marginatus Mountain brome				2	2	2	2	2
Agropyron smithii rosano - Western wheatgrass	2	2	2	1	1	1	1	1
Agropyron trachycaulum Slender wheatgrass	1	1						
Cerocarpus montanus Mountain Mahogany	1/2	1/2		1/2	1/2	1/2	1/2	1/2
Elymus cinereus Basin wildrye			1					
Hedysarum boreale utah Sweetvetch	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
Koeleria gracilis June grass	2	2		2	2	2	2	2
Oryzopsis hymedoides Indian ricegrass	1	1	1	1	1	1	1	1
Purshia tridentata Antelope bitterbrush								
Stipa comata Green needlegrass			1/2					
Symphoricarpus oreophilus Snowberry	1/2	1/2		1/2	1/2	1/2	1/2	1/2
TOTAL	11½	11½	11	11½	11½	11½	11½	11½

TABLE III B -1 Cont.

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SITE PLANTING PLAN Species	SG14/A10, Valley Bottom sagebrush, Middle Stewart Gulch lbs./acre	SG15, Chained Pinyon-Juniper, ridge between Scandard and Sorghum Gulches lbs./acre	SG16, Chained Pinyon-Juniper and Plateau Sage. site near Vegetation Plot #3 lbs./acre	SG17, Pinyon-Juniper ridge between West Stewart and Middle Stewart Gulches lbs./acre	SG18, 183, Plateau sage-brush, head of Sorghum Gulch lbs./acre	SG-19/A-7, Valley Bottom Sagebrush, on Piceance Creek at mouth of Sorghum Gulch lbs./acre	SG20/A-6, Valley Bottom Sagebrush, on Piceance Creek Road, big cut in hill side next to it lbs./acre	SG21, Valley Bottom Sagebrush, Scandard Gulch lbs./acre
Agropyran intermedium amur - Intermediate wheatgrass	2	2	2	2	2	2	2	3
Agropyron sibircum Siberian wheatgrass	3	2	2	2	2	3	3	3
Bromus marginatus Mountain brome	2	2	2	2	2	2	2	3
Agropyron smithii rosano - Western wheatgrass		1	1		1			
Agropyron trachycaulum Slender wheatgrass				1				
Cercocarpus montanus Mountain Mahogany		1/2	1/2		1/2			
Elymus cinereus Basin wildrye	1					1	1	
Hedysarum boreale utah Sweetvetch	1/2	1/2	1/2		1/2	1/2	1/2	1/2
Koeleria gracilis June grass		2	2	2	2			
Oryzopsis hymedoides Indian ricegrass	1	1	1	1	1	1	1	1
Purshia tridentata Antelope bitterbrush	1			1/2		1	1	1/2
Stipa comata Green needlegrass	1/2					1/2	1/2	1
Symphoricarpus oreophilus Snowberry		1/2	1/2	1/2	1/2			
TOTAL	11	11½	11½	11	11½	11	11	12

TABLE III B-2

SITE PLANTING PLAN

Site Description and Location	Planting Period	Seed Application	Seedbed Preparation	Mulching Treatment	Fertilizer	Fencing	Remarks
Air Quality Meteorological Tower, Chained Pinyon-Juniper	Oct. 15 - Nov. 15	broadcast and drill	hand scarification	distribute slash	none	none	provide gravelled access to tower and instrument site
A-1, Valley Bottom Sagebrush, near main turnoff on Piceance Creek Road	Oct. 15 - Nov. 15	drill	harrow lightly with pipe harrow	none	none	none	favorable site for rehabilitation
A-2, Valley Bottom Sagebrush, pasture	- - - -	- - - -	none, leave as is	- - - -	- - - -	- - - -	vegetation cover has been naturally established
A-3, Valley Bottom Sagebrush, in Scandard Gulch	Oct. 15 - Nov. 15	drill	harrow lightly	none	none	none	less than 1/10 acre next to road, favorable site
A-4, Valley Bottom Sagebrush head of Scandard Gulch	Oct. 15 - Nov. 15	drill	harrow lightly	none	none	none	favorable site, western wheat grass seedlings scattered
A-5, Valley Bottom Sagebrush on Piceance Creek at mouth of Cottonwood Gulch	Oct. 15 - Nov. 15	drill	harrow lightly	none	none	3 strand barbwire	favorable site, base of north slope
A-6/SG-20, Valley Bottom Sagebrush, on Piceance Creek Road, big cut in hill side next to it	Oct. 15 - Nov. 15	drill	harrow lightly	none	none	3 strand barbwire	favorable site, base of north slope
A-7/SG-19, Valley Bottom Sagebrush, on Piceance Creek at mouth of Sorghum Gulch	Oct. 15 - Nov. 15	drill	harrow lightly	none	none	3 strand barbwire	favorable site, base of north slope
A-8, Valley Bottom, Sagebrush, lower Stewart Gulch	Oct. 15 - Nov. 15	drill	harrow lightly	none	none	3 strand barbwire	favorable site
A-9/SG-8, Valley Bottom Sagebrush, near Oldland Summer Camp	Oct. 15 - Nov. 15	drill	harrow lightly, pit needs cover and litter cleanup	- - - -	- - - -	already in fenced area	area could also be smoothed when pit is covered up
A-10/SG-14, Valley Bottom Sagebrush, middle Stewart Gulch	Oct. 15 - Nov. 15	drill	harrow lightly	none	none	3 strand barbwire	5 foot cut on west side may require broadcast seeding and mulch excelsior

TABLE III B-2 Cont.
SITE PLANTING PLAN

A-11, Valley Bottom Sagebrush West Stewart, just past turnoff to ridge met. tower.	Oct. 15 - Nov. 15	drill	harrow lightly	none	none	3 strand barbwire	favorable site
A-12, Valley Bottom Sagebrush, Upper West Stewart Gulch	Oct. 15 - Nov. 15	drill	lightly harrow	none	none	3 strand barbwire	favorable site
A-13, Valley Bottom Sagebrush in wash at head of Sorghum Gulch	Oct. 15 - Nov. 15	drill with some broadcasting	lightly harrow	none	none	none	favorable site, small area about 20 to 50 feet
C-b2, Chained Pinyon-Juniper ridge east of Cottonwood Gulch	Oct. 15 - Nov. 15	drill and broadcast	pad requires minimal roughing; no re-contouring is necessary	none	none	none	this site shows voluntary establishment of permanent vegetation
C-b4, Chained Pinyon-Juniper ridge west of Stewart Gulch	Oct. 15 - Nov. 15	broadcast and drill	minor ripping and scanfication, re-contour	none	none	none	- - - -
NG4, Chained Pinyon-Juniper ridge West of Scandard Gulch	Oct. 15 - Nov. 15	drill and broadcast	lightly harrow after recontouring	none	less than 80 lbs. available N.P.K./acre in summer of 1976	none	include roadway; water bars needed on roadway site
NG7/SG-7, Chained Pinyon-Juniper, ridge West of West Stewart Gulch	Oct. 15 - Nov. 15	broadcast and drill	rip and cover with available fine material	replace slash	none	none	- - - -
NG12-SG12. Chained Pinyon-Juniper, ridge East of Sorghum Gulch	Oct. 15 - Nov. 15	broadcast and drill	recontour pad; rough and distribute slash	none	none	none	no monitoring access required; some device needed to prevent vehicular traffic
SG1, Valley Bottom Sagebrush. mouth of Scandard Gulch	Oct. 15 - Nov. 15	drill	(pad has been prepared)	none	none	3 strand barbwire	access for well monitoring required
SG2. Chained Pinyon-Juniper ridge west of Cottonwood Gulch	Oct. 15 - Nov. 15	drill and broadcast	recontouring followed by light harrowing	straw or excelsior on cat area	less than 80 lbs. available N.P.K./acre in summer of 1976	none	cut slope requires broadcasting and mulching
SG3, Chained Pinyon-Juniper, ridge East of Sorghum Gulch	Oct. 15 - Nov. 15	drill and broadcast	harrow lightly	none	less than 80 lbs. available N.P.K./acre in summer of 1976	none	- - - -

TABLE III B-2 Cont.
SITE PLANTING PLAN

SG4, Chained Pinyon-Juniper ridge between Scandard and Little Scandard Gulches	Oct. 15 - Nov. 15	drill and broadcast	harrow lightly	none	less than 80 lbs. available N.P.K./acre in summer of 1976	none	- - - -
SG5, Chained Pinyon-Juniper West of Support Facility	Oct. 15 - Nov. 15	drill and broadcast	light harrowing following re-contouring	possibly on 6 foot cut	less than 80 lbs. available N.P.K./acre in summer of 1976	none	- - - -
SG6, Chained Pinyon-Juniper ridge West of Sorghum Gulch	Oct. 15 - Nov. 15	drill and broadcast	Fine material on edges of bed should be pulled back on pad. Slush should be spread on pad. Minimal roughing with pipe harrow; no contouring.	- - - -	none	none	retain gravel access to monitoring shea
SG7/NQ7, Chained Pinyon-Juniper, ridge West of West Stewart Gulch	Oct. 15 - Nov. 15	broadcast and drill	rip and cover with available fine material	replace slaash	none	none	- - - -
SGS/A-9, Valley Bottom Sagebrush, near Oldland Summer Camp	Oct. 15 - Nov. 15	drill	harrow lightly. Pit needs covered and litter cleaned up.	- - - -	- - - -	already in fenced-in area	area could also be amoothed when the pit is covered up
SG9, Chained Pinyon-Juniper, ridge above Scandard Gulch	Oct. 15 - Nov. 15	drill and broadcast	harrow lightly	none	less than 80 lbs. available N.P.K./acre in summer of 1976	none	- - - -
SG10, Pateau Sage/Chained Pinyon-Juniper, near met. tower	Oct. 15 - Nov. 15	broadcast and drill	pad needs minimal roughing and pipe harrow	none	none	none	maintain monitoring access
SG11, Chained Pinyon-Juniper, ridge East of Sorghum Gulch	Oct. 15 - Nov. 15	drill and broadcast	harrow lightly	none	less than 80 lbs. available N.P.K./acre in summer of 1976	none	- - - -
SG12/NQ12, Chained Pinyon-Juniper, ridge East of Sorghum Gulch	Oct. 15 - Nov. 15	broadcast and drill	recontour pad; rough and distribute slash	none	none	none	no monitoring access required; some device needed to prevent vehicular traffic
SG13, Chained Pinyon-Juniper lower ridge West of West Stewart Gulch	Oct. 15 - Nov. 15	drill and broadcast	light harrowing; restore contour	none	none	none	- - - -

TABLE III B-2 Cont.
SITE PLANTING PLAN

SG14/A-10, Valley Bottom Sagebrush, Middle Stewart Gulch	Oct. 15 - Nov. 15	drill	harrow lightly	none	none	3 strand barbwire	5 foot cut on West side may require broadcast seeding and mulch exelsior
SG15, Chained Pinyon-Juniper, ridge between Scandard and Sorghum Gulches	Oct. 15 - Nov. 15	broadcast and drill	rip surface recontour pad; pull back toe of pad; replace fine material stockpiled; distribute slash	- - - -	none	none	include several shrub species as transplants as follow-up
SG16, Chained Pinyon-Juniper and Plateau sage, site near Vegetation Plot #3	Oct. 15 - Nov. 15	drill and broadcast	minimal roughing and pipe harrow; toe of pad should be pulled back	- - - -	none	none	place water bars adjacent to drainings to disperse runoff onto pad; plans include access roadway
SG17, Pinyon-Juniper, ridge between West Stewart and Middle Stewart Gulches	Oct. 15 - Nov. 15	broadcast	rip surface; replace debris and fine material	none	none	none	allow access through pad/shrub sod; Pinyon and Juniper set outs as follow-up
SG18a, Plateau Sagebrush, head of Sorghum Gulch	Oct. 15 - Nov. 15	drill and broadcast	pad has been ripped and recontoured	none	none	3 strand barbwire	must allow access for monitoring and through pad
SG19/A-7, Valley Bottom Sagebrush, on Piceance Creek at mouth of Sorghum Gulch	Oct. 15 - Nov. 15	drill	harrow lightly	none	none	3 strand barbwire	favorable site, base of north slope
SG20/A-6, Valley Bottom Sagebrush, on Piceance Creek Road, big cut in hill side next to it	Oct. 15 - Nov. 15	drill	harrow lightly	none	none	3 strand barbwire	favorable site; base of north slope
SG21, Valley Bottom Sagebrush, Scandard Gulch	Oct. 15 - Nov. 15	drill	(seedbed has been roughed) terrace slopes above and below roadway	none	none	3 strand barbwire	fence pad on either side of road; plant shrub species on lower slope terraces

III C MICROENVIRONMENTAL PROGRAM

Data collected from the four continuous recording microenvironmental stations and the thirteen relocatable spot-check stations during May and June are summarized in Tables III C-1 and III C-2. The operation of these stations and the parameters measured have previously been described in Quarterly Data Reports #1 and #2 and in Summary Reports #1 and #2.

It is anticipated that subsequent reports will contain some substantive discussion of these data as they pertain to typification of the microenvironment on Tract C-b and its relationship to plant and animal activity.

TABLE III C-1
MICROENVIRONMENTAL STATIONS
MONTHLY SUMMARY
MAY, 1975

STATION NUMBER	SOIL TEMPERATURE °C			AIR TEMPERATURE °C					SOIL MOISTURE %			PRECIPITATION, Total cm*	RELATIVE HUMIDITY, %	WIND SPEED MPH		WIND DIRECTION °Azimuth		NET SOLAR RADIATION, Langleys	VEGETATION TYPE AND LOCATION
	-60 cm	-40 cm	-20 cm	0 cm	1 meter	3 meters	Minimum, Absolute	Maximum, Absolute	-60 cm	-40 cm	-20 cm			1 meter	3 meters	1 meter	3 meters		
1			()				()	()	*	*	38.0	()	()						CHAINED PINYON-JUNIPER RANGELAND (Vegetation Plot #1)
2			()				()	()	*	*	39.3	()	()						CHAINED PINYON-JUNIPER RANGELAND (Vegetation Plot #2)
3@	7.1	7.2	7.0	7.0	7.5		-1.5	22.0	40.8	45.5	32.8	2.62	()	5.6		153			PLATEAU SAGEBRUSH (Vegetation Plot #3)
4@	5.9	6.8	8.0	8.2	5.6		-7.0	45.0	31.5	32.5	()	2.59	()	1.4		149			VALLEY BOTTOM SAGEBRUSH (Vegetation Plot #4)
5			()				()	()	*	*	[illegible]	()	()						PINYON-JUNIPER WOODLAND (Vegetation Plot #5)
6@	2.1	2.4	3.1	4.6	3.5		-5	25.0	33.3	37.3	30.8	3.40	24	1.6		174			PINYON-JUNIPER WOODLAND (Vegetation Plot #6)
7@	6.9	7.4	8.5	11.6	8.0	7.4	-7.6	48.1	()	()	()	.53	()	2.2	3.5	190	175	()	CHAINED PINYON-JUNIPER RANGELAND (Animal Trapping Grid)
8			()				1.0	41.0	21.5	14.0	()	0.64	31						BUNCHGRASS COMMUNITY (South-Facing Slope)
9			16.3				2.0	34.0	20.0	21.5	21.5	()	26						VALLEY BOTTOM SAGEBRUSH (Mouth of Sorghum Gulch)
10			()				()	()	()	()	()	()	()						RABBITBRUSH COMMUNITY (Mouth of West Stewart Gulch)
11			()				()	()	*	*	20.5	()	27						BUNCHGRASS COMMUNITY (West-Facing Talus Slope)
12			()				()	()	27.6	25.0	()	()	26						VALLEY BOTTOM SAGEBRUSH (Alluvial)
13			()				-10.0	32.0	*	*	28.5	5.59	36						MIXED MOUNTAIN SHRUBLAND (North-Facing Slope)
14			()				()	()	30.0	35.5	()	()	()						PINYON-JUNIPER WOODLAND (West-Facing Slope)
15			()				()	()	31.0	40.5	()	()	()						PINYON-JUNIPER WOODLAND (Cottonwood Gulch)
16			()				()	()	38.0	33.5	()	()	()						PLATEAU SAGEBRUSH (Head of Sorghum Gulch)
17			()				()	()	31.5	34.5	()	()	()						ANNUAL WEED COMMUNITY (Abandoned Drill Pad)

@ Continuous Recording Stations
* Precipitation Values Are Totals For Period, Minimum And Maximum Temperature Values Are Absolute; All Other Values Are Expressed As Means
(shaded) Values Not Measured At These Stations
() Values Not Available For This Period Due To Instrument Failure

TABLE III C-2
MICROENVIRONMENTAL STATIONS
MONTHLY SUMMARY
JUNE, 1975

STATION NUMBER	SOIL TEMPERATURE °C			AIR TEMPERATURE °C					SOIL MOISTURE %			PRECIPITATION, Total cm*	RELATIVE HUMIDITY, %	WIND SPEED MPH		WIND DIRECTION °Azimuth		NET SOLAR RADIATION, Langleys	VEGETATION TYPE AND LOCATION
	-60 cm	-40 cm	-20 cm	0 cm	1 meter	3 meters	Minimum, Absolute	Maximum, Absolute	-60 cm	-40 cm	-20 cm			1 meter	3 meters	1 meter	3 meters		
1			22.5				-7.0	31.0			69.7	()	29						CHAINED PINYON-JUNIPER RANGELAND (Vegetation Plot #1)
2			18.0				-2.6	31.0			54.8	()	23						CHAINED PINYON-JUNIPER RANGELAND (Vegetation Plot #2)
3@	10.3	10.8	11.0	12.4	12.0		-1.5	41.0	77.2	82.8	69.1	2.49	47	4.4		143			PLATEAU SAGEBRUSH (Vegetation Plot #3)
4@	11.5	12.7	14.1	13.5	11.0		-3.5	35.0	59.5	59.7	()	4.62	32	1.2		175			VALLEY BOTTOM SAGEBRUSH (Vegetation Plot #4)
5			21.0				-5.0	34.0			49.9	2.18	30						PINYON-JUNIPER WOODLAND (Vegetation Plot #5)
6@	8.2	9.1	10.5	12.8	10.1		-3.0	37	61.0	68.6	()	6.99	29	0.7		168			PINYON-JUNIPER WOODLAND (Vegetation Plot #6)
7@	10.7	11.6	13.0	15.2	13.1	13.0	-5.0	43.7	69.4	65.0	()	3.28	31	2.0	3.2	190	170	()	CHAINED PINYON-JUNIPER RANGELAND (Animal Trapping Grid)
8			21.5				3.0	39.0	42.3	()	()	1.52	27						BUNCHGRASS COMMUNITY (South-Facing Slope)
9			16.0				-7.0	30.0	36.6	34.8	()	3.05	27						VALLEY BOTTOM SAGEBRUSH (Mouth of Sorghum Gulch)
10			15.5				()	()	()	34.3	33.9	()	31						RABBITBRUSH COMMUNITY (Mouth of West Stewart Gulch)
11			13.0				()	()			39.2	()	46						BUNCHGRASS COMMUNITY (West-Facing Talus Slope)
12			14.0				()	()	()	49.9	45.4	()	51						VALLEY BOTTOM SAGEBRUSH (Alluvial)
13			15.0				-5	31			53.0	3.30	46						MIXED MOUNTAIN SHRUBLAND (North-Facing Slope)
14			12.0				-5	32	50.8	58.8	()	()	36						PINYON-JUNIPER WOODLAND (West-Facing Slope)
15			()				-5	34	()	59.2	67.7	3.68	41						PINYON-JUNIPER WOODLAND (Cottonwood Gulch)
16			()				()	()	74.8	65.4	57.9	4.70	36						PLATEAU SAGEBRUSH (Head of Sorghum Gulch)
17			()				()	()	60.6	60.6	()	()	38						ANNUAL WEED COMMUNITY (Abandoned Drill Pad)

@ Continuous Recording Stations
* Precipitation Values Are Totals For Period, Minimum And Maximum Temperature Values Are Absolute; All Other Values Are Expressed As Means
(shaded) Values Not Measured At These Stations
() Values Not Available For This Period Due To Instrument Failure

III D AERIAL PHOTOGRAPHIC PROGRAM

No additional information has been produced from this program to date. It is anticipated that one additional flight will be conducted during the two-year baseline study. This flight will be accomplished at an as-yet undetermined date prior to June, 1976.

III E ARCHAEOLOGICAL STUDIES

The Final Report, "Cultural and Paleontological Resources - Federal Oil Shale Lease Tract C-b", is included in Quarterly Data Report #2. At this time, no additional archaeological work is planned, with the exception of the reconnaissance studies being performed in all areas which are planned for surface disturbance during the Exploration Phase. In addition, test-excavations may become necessary if sites which are identified in the Final Report are disturbed.

III F SCENIC VALUES PROGRAM

OBJECTIVES

This study was undertaken to determine the type and quality of the scenic resources presently existing in the Tract C-b area. The objectives of the study were to characterize the scenic elements of the Piceance Basin both as they relate specifically to the Tract and also as they are related to the scenic resources of surrounding areas in Western Colorado. This information was then used to define and evaluate areas of visual sensitivity on Tract C-b. General guidelines developed by the Forest Service were adopted to minimize visual impacts occurring during development.

METHODS

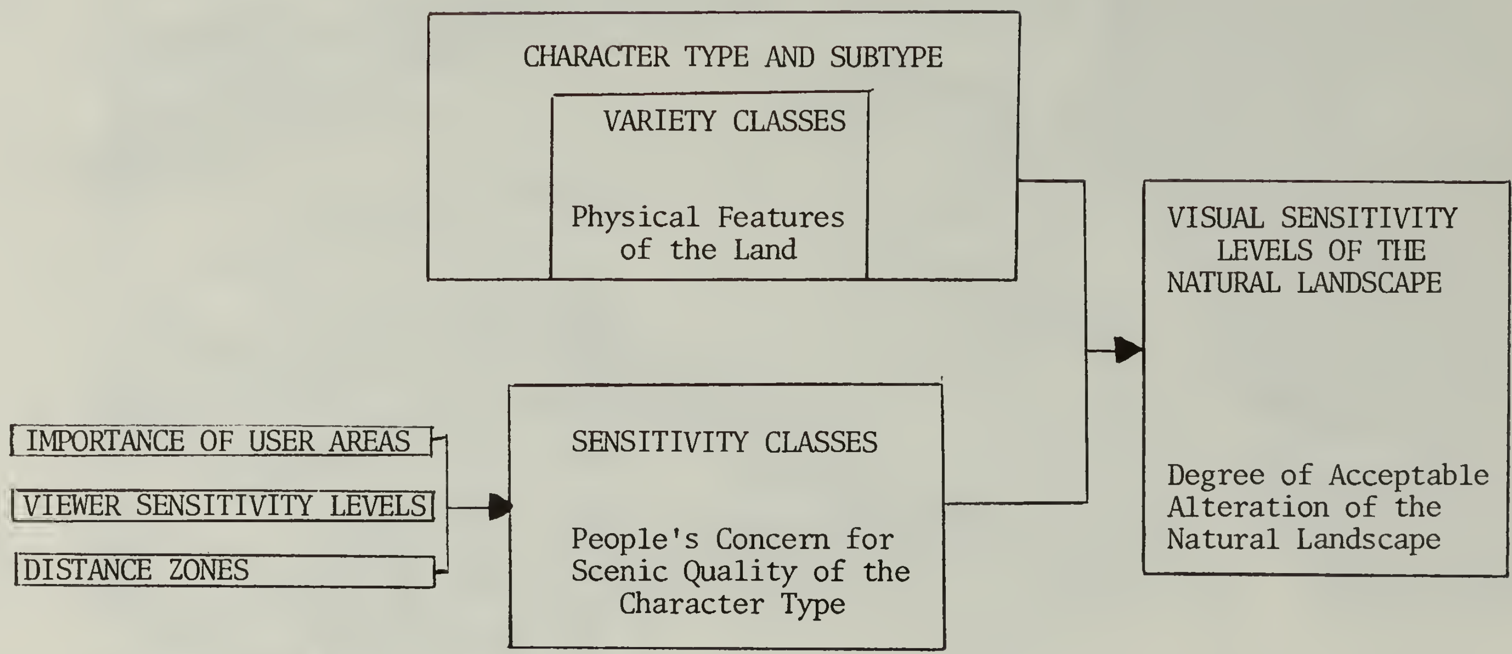
The methodology and guidelines used in this study are those used by the U. S. Forest Service in its Visual Management System (USDA Handbook No. 462). A diagrammatic representation of this methodology is shown in Figure III F-1. This figure shows the steps which are followed in this methodology to arrive at a determination of the visual sensitivity of the natural landscape. A complete discussion of each phase of the study follows. The intensive study area covers Tract C-b and a zone within 4 miles of the Tract boundary (Figure III F-2).

LANDSCAPE FACTORS

Character Type

Visual Character Type is based on common distinguishing visual characteristics of an area of land. Character Type is determined, in this U. S. Forest Service method, by physiographic sections as defined by Fenneman in Physiography of the Western United States. The Piceance Basin is included in Fenneman's Uinta Basin section, which is continuous with a strip of high plateaus on the western border of the Colorado Plateau province. A 50-100 mile strip running east along the northern border of this physiographic section abuts with the Uinta Mountains on the north. The southern portion of the section is composed of north-dipping beds which are limited on their southern edge by the escarpment of the Book Cliffs; the higher portion of the southern margin is the Tavaputs Plateau. The interior of the section, which is for the most part lower than its edges, is a plateau area dissected by streams, with relatively narrow patches existing between headwaters.

FIGURE III F-1 USFS VISUAL MANAGEMENT SYSTEM



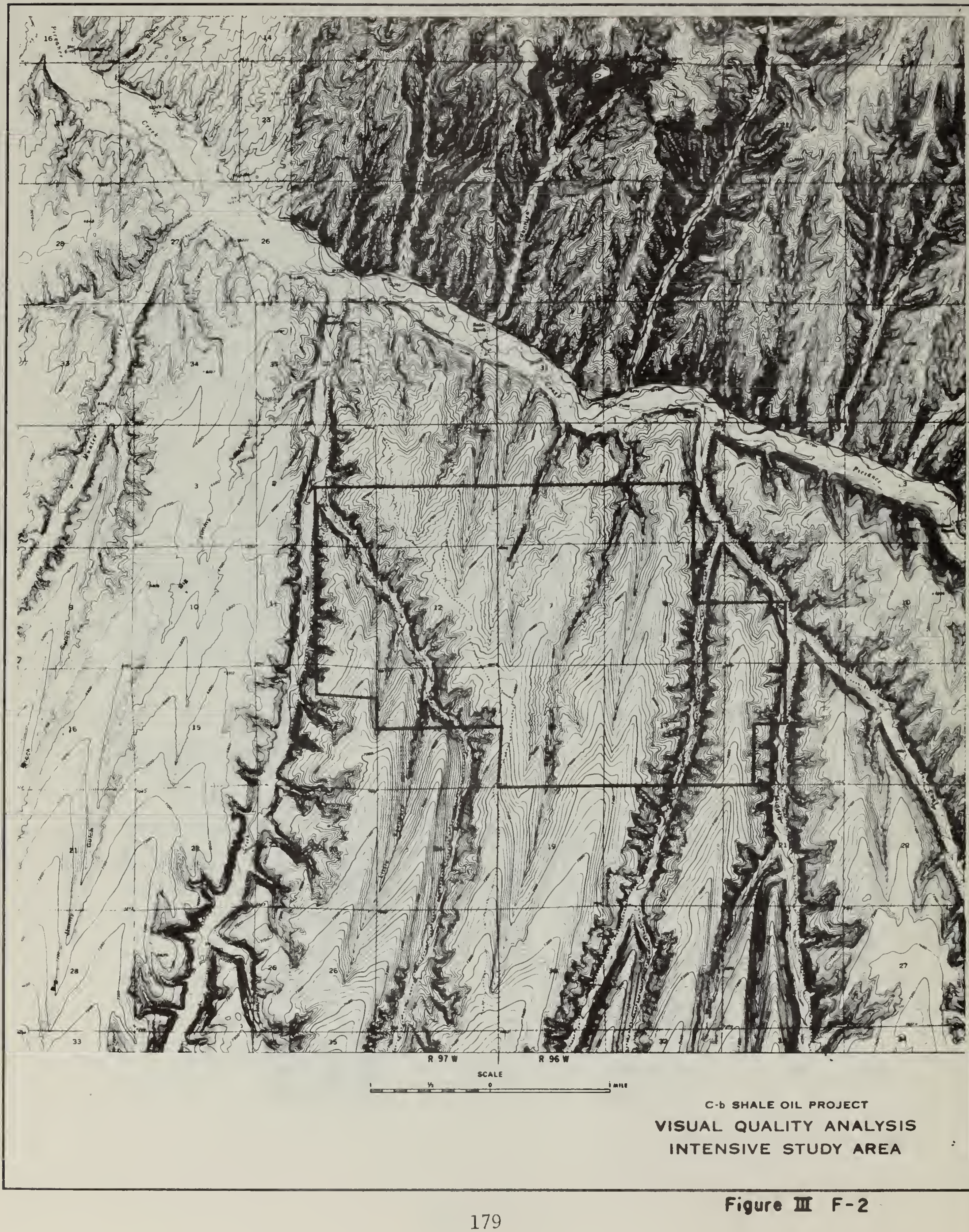


Figure III F-2

Character Subtypes

In order to describe more effectively the landscape types of a diverse region such as the Uinta Basin, it is necessary to define visually distinct Subtypes of this Character Type. Those visual Subtypes described in this study surround the Piceance Basin Subtype. These surrounding Subtypes are the Book Cliffs, Roan Cliffs, Colorado River Valley, Grand Mesa, Grand Hogback, Colorow Mountains, Flattops, and Cathedral Bluffs-Douglas Creek. These Subtypes are shown in Figure III F-3 and described below in terms of form, line, color and texture - the basic components of any landscape.

1. Piceance Basin

   This subtype is characterized by a gently sloping basin which is moderately dissected by parallel streambeds. The stream valleys are bordered by walls which vary from steep cliffs to gentle slopes. Streambeds are generally narrow and most are ephemeral. These streams lead to the Piceance Creek valley, which is a slightly larger version of its tributaries. Line is smooth and strongly horizontal. Colors are the beige of the eroded sandstone substrate and rock outcroppings, the muted green of sagebrush and darker greens of pinyon-juniper and Douglas fir vegetation. Valley bottoms range in color from sage green to the brighter green of irrigated hay meadows. Texture ranges from the very smooth irrigated meadows to coarser rock outcroppings and fairly coarse mottled natural vegetation areas.

2. Book Cliffs

   This subtype is characterized by cliffs approximately 2000 feet high which are capped with strong horizontal sandstone layers. Steeply eroded, sharp-angled gullies on the cliff faces lead down into flat, gently rolling terrain. The cliff top forms a strong line cutting horizontally across the skyline. The predominant colors of the landscape are the gray of the bottom of the cliffs which grades into light beige at the top, intermixed with sandy pink and gold-toned horizontal bands. The texture of the cliffs is smooth, as there is no vegetation on them, and this grades into the fine texture of the sparse vegetation on the lower terrain.

3. Roan Cliffs

   This subtype is characterized by cliffs approximately 3000 feet high with massively blocky forms at the top. The cliff faces have highly eroded, long steep slopes which are interspersed with areas of relatively small jutting rocks of strong form. The cliff tops cut into the skyline with a rounded, massively blocky line. The color of the landscape is light gray with several horizontal reddish bands near the bottom of

VISUAL CHARACTER SUB TYPES

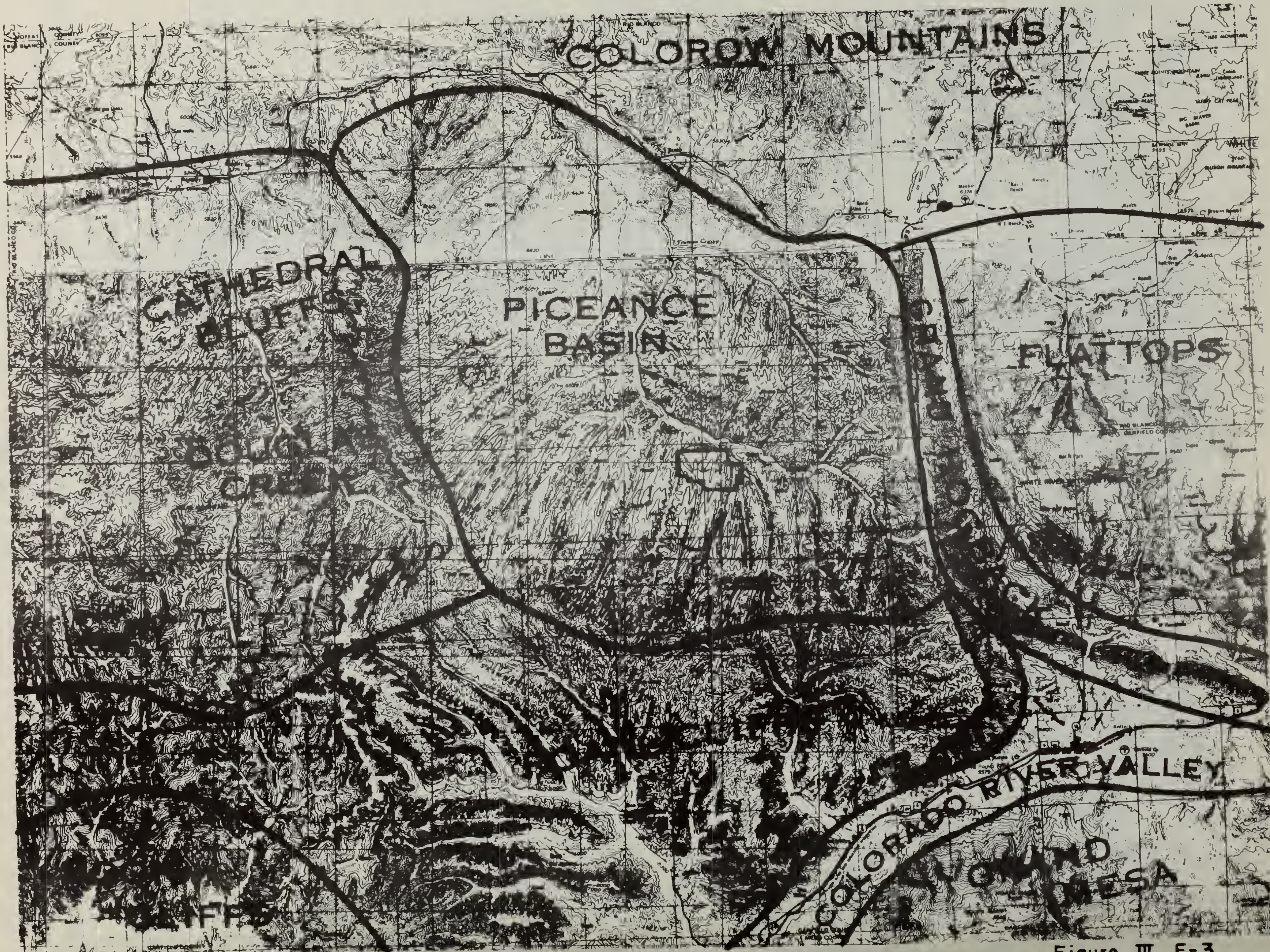


Figure III F-3

the cliffs. The texture of the steep eroded slopes is smooth, interspersed with areas of coarse texture which result from the occurrence of juniper and Douglas fir vegetation.

4. Colorado River Valley

This subtype is characterized by benchlands formed by the cutting of the river, bordered by tall trees. The lines are strong, low, and horizontal. Colors of vegetation range from sage green to dark green as the results of extensive agricultural and residential uses and from cottonwoods along the river. Soils are beige in color. The texture is moderately coarse, with the cottonwoods giving a rough texture contrasting with the smoothness of the river.

5. Grand Mesa

This subtype consists of a flat to very gently rolling mesa top situated at a 10,000 foot elevation, becoming more rolling to the east, with slightly angular foothills having gently sloping sides. The line is strongly horizontal and is strengthened by a 200-300 foot escarpment immediately below the mesa top. Color is primarily the dark green of evergreens. Texture varies from the smooth, large open spaces of the western portion of the mesa top which contain large groves of coarse-textured evergreen, to the coarse texture of the continuous tree cover of the of the top, both of which are interspersed with many The foothills are coarsely-textured, owing to the heavy evergreen forest cover.

6. Grand Hogback

This subtype is characterized by strongly upwarped strata of a pointed and plate-like form rimmed by rock, fading into regularly-spaced, rounded mountains. Line is predominantly the diagonals of the tilted strata. The vegetation on the mountains (mountain shrub, pinyon-juniper and Douglas fir) is of a dark green color and coarse texture and is interspersed with the banded (reddish, beige, yellowish) color and smoother texture of the exposed rock outcroppings.

7. Colorow Mountains

This subtype has a subdued, very slightly angular mountainous form, with a moderate horizontal line type. Colors are the dark muted-green tones of the vegetation (pinyon-juniper type) and the beige of the rock. Rock covered by a mottled vegetation pattern gives a slightly coarse texture.

8. Flattops

The form of this subtype is one of high, uplifted flat volcanic strata, deeply cut by narrow river valleys. Line is strongly horizontal on the top, becoming steep to moderately angular in

the foothills. Colors range from dark green of evergreens to lighter green of aspen and interspersed grass parks. This varied vegetation results in a moderately coarse texture.

9. Cathedral Bluffs - Douglas Creek

   This subtype is characterized by a rolling, angular, low mountain form. Horizontal line predominates in the rock strata of Cathedral Bluffs, with angular line occurring in the other hill areas of the subtype. Colors are the sage green of the vegetation, alternating with light beige of the earth. The resulting texture is moderately coarse.

When compared with most of the other Subtypes of the region, it is evident that the Piceance Basin is less notable in terms of strength of form and line, and ranks fairly equally with regard to color and texture variations.

VARIETY CLASSES

Within the confines of the Piceance Basin there is considerable variation in landform, rockform, vegetation and waterforms. This variation is accounted for by defining a series of Variety Classes which depict the inherent scenic quality of the landscape. The human aspects will be considered below. A series of criteria (Table III F-1) were used to differentiate the Variety Classes (Distinctive, Common, Minimal) which exist in the Piceance Basin. In practice it was convenient to identify the Distinctive and Minimal areas on a map and to assume the remainder was Common. Examples of these various Variety Classes are shown in Figures III F-4 through III F-7 and a map of Variety Classes in Figure III F-8. Only one Distinctive area was found on the Tract. It consists of the cliffs at the mouth of Scandard Gulch. Several other Distinctive areas are located off-tract with most of these also being dominant rockforms. The Minimal areas of the study area are quite extensive and cover a considerable portion of the Tract and nearby Hunter-Willow Ridge. These areas have been either chained or sprayed to destroy woody vegetation within the past ten years.

HUMAN FACTORS

In order to account for the human aspects of the visual experience in this scenic quality analysis, the methodology incorporates measures of the relative importance of use areas, water bodies and travel routes viewers' concern for scenic values and the distance from which the landscape is viewed. The rationale used to account for each of these factors will be discussed below.

Importance of User Areas

User Areas such as roads, trails, overlooks, camp sites, ranch headquarters, cow camps, ponds and streams are rated as being of primary

TABLE III F-1

VARIETY CLASSES DETERMINATION*

	DISTINCTIVE	COMMON	MINIMAL
LANDFORM	Cliffs on valley sides Highly eroded slopes	Moderately steep valley sides, flat ridge tops and flat valley bottoms	Extensive flat ridge tops or valley floors
ROCKFORM	Rock features which stand out on landform Unusual rock strata exposures	Rock features obvious but do not stand out	Rock features small to nonexistent
VEGETATION	High degree of patterns in vegetation High diversity in plant forms Relatively large stands of trees	Continuous vegetative cover with some degree of pattern Low diversity in plant forms Irrigated meadows	Continuous vegetative cover with little or no pattern Chained or sprayed areas Non-irrigated valley bottoms
LAKES, PONDS	Irregular shorelines Greater than one acre in size	Regular shorelines Less than one acre in size	No lakes or ponds
STREAMS, SPRINGS AND SEEPS	Springs and seeps which form ponds Perennial streams Large volume	Springs and seeps which do not form ponds Ephemeral streams Low volume	No streams, springs or seeps

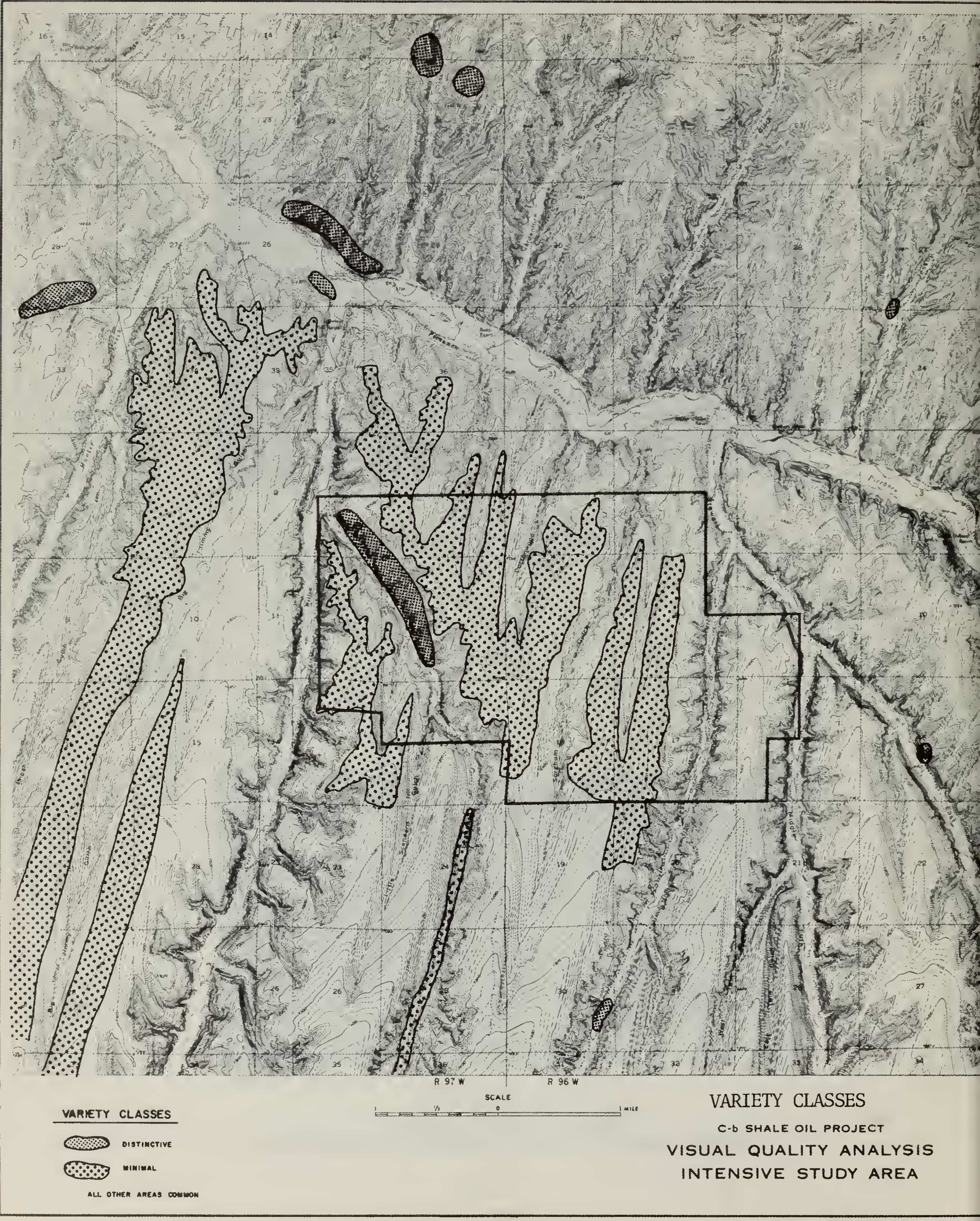
*Only one of the criteria had to be met for an area to be classed as Distinctive, whereas two or three criteria had to be met for an area to be classed as Minimal. This allowed Distinctive areas to be readily identified while Minimal areas needed considerably more factors for them to be classified.

Figure III F-4
DISTINCTIVE ROCKFORM

Figure III F-5
COMMON VEGETATION

Figure III F-6
MINIMAL VEGETATION AND LANDFORM

Figure III F-7
COMMON LANDFORM AND DISTINCTIVE WATERFORM



VARIETY CLASSES

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Figure III F-8

or secondary importance based on size, volume of use, duration of use, recreational use, and local importance. In this study User Importance was considered only in terms of use factors within the Piceance Basin. These factors are shown in Table III F-2 and a map of Primary and Secondary User Areas identified in the study area are shown in Figure III F-9. No User Areas of national importance exist in the Piceance Basin. User volume, duration of use and size were the criteria used to differentiate User Areas.

The only Travel Routes rated as being of Primary Importance were the Piceance Creek Road and the Collins Gulch Road. Piceance Creek Road is used by local residents, drilling crews, and governmental personnel. It is not a scenic highway as is the Rifle-Meeker-Rangely road along the Hogback and White River (as indicated on many traveler highway maps). In fact until it was completely paved several years ago, the Piceance Creek Road did not appear on many highway maps. Collins Gulch Road serves the employees of a gas adsorption plant located north of Tract C-b. All other roads were classed as being of Secondary Importance because of the lower traffic volumes and seasonality of use. These roads are used primarily by local ranches for movement of cattle and sheep and by hunters in search of deer and elk.

Use Areas of Primary Importance are the ranch headquarters, all of which are situated on the Piceance Creek Road. All other Use Areas and Water Bodies were classed as being of Secondary Importance because of low volume of use and low recreation use.

Viewer Sensitivity Levels

To account for the concern for scenic values which the users of the Piceance Basin have, a matrix was developed incorporating the importance of User Areas and an appraisal of the percentage of users having SOME concern for scenic values (Table III F-3). The Forest Service method bases its user concern for scenic values on a percentage of viewers having a MAJOR concern for scenic values. The Forest Service assumes that persons having a MAJOR concern for scenic values are those engaged in driving for pleasure, hiking scenic trails, camping at primary use areas, and those using lakes and streams in conjunction with other forms of recreational activities. Minor concern for scenic values is assumed to be held by persons involved with daily commuter driving, hauling forest products, and those employed in other commercial uses of the forest. It is estimated that less than 10 percent of all Piceance Basin users have a MAJOR concern for scenic values. Since no hard data on which to base this 10 percent estimate was available, a liberal approach was taken by stating that users had SOME concern for scenic values. This permitted use of areas representing all Sensitivity Levels. Travel routes and use areas depicted in Figure III F-9 were allocated to various Sensitivity Levels (Table III F-3). The Piceance Creek Road and ranch headquarters were placed in Sensitivity Level 1 since it was assumed that at least 25 percent of the users had SOME concern for scenic values. Collins Gulch Road was judged to have fewer users concerned about scenic values and was therefore placed in Sensitivity Level 2. All other roads in the intensive study area were also placed in Sensitivity Level 2 because, while they are of secondary

TABLE III F-2
USER AREA CRITERIA

	PRIMARY IMPORTANCE	SECONDARY IMPORTANCE
TRAVEL ROUTES Roads Trails	High use volume Major access road Long use duration	Low use volume Project road Short use duration
USE AREAS Overlooks Camp areas Ranch headquarters Cow camps	Large size Long use duration High use volume	Small size Short use duration Low use volume
WATER BODIES Ponds Streams	High recreation use	Low recreation use

TABLE III F-3

VIEWER SENSITIVITY LEVELS

User Area	Viewer Sensitivity Levels		
	1	2	3
Primary	At least 1/4 of users have SOME concern for scenic values (PICEANCE CREEK ROAD AND RANCH HEADQUARTERS).	Less than 1/4 of users have SOME concern for scenic values (COLLINS GULCH ROAD)	
Secondary	More than 3/4 of users have SOME concern for scenic values.	Between 3/4 and 1/4 of users have SOME concern for scenic values (ALL OTHER INTENSIVE STUDY AREA ROADS)	Less than 1/4 of users have SOME concern for scenic values (AREAS NOT SEEN FROM ANY USER AREA)

Figure III F-9

importance, a considerable number of users (deer hunters and local ranchers) were assumed to have SOME concern for scenic values while engaged in their primary goals. All areas not seen from any travel route or use area were placed in Sensitivity Level 3 - the lowest level.

Distance Zones

As a general rule, the closer a viewer is to an alteration in the natural landscape, the more obvious the alteration is. A means of accounting for how closely different sections of the study area are viewed by users is to define Distance Zones (Table III F-4) and then view the landscape from each User Area and delineate each zone on a map. This mapping was done in the field, with all User Areas being mapped separately, Then all Distance Zone maps were overlayed and Sensitivity Levels of each User Area were utilized to set priorities in developing a composite Distance Zone/Sensitivity Level map, Figure III F-10. In all cases the most restrictive Sensitivity Level was used in the composite map.

SENSITIVITY CLASSES

The final step in depicting the Sensitivity Classes which exist on Tract C-b was to overlay the Variety Class map with the Distance Zone/Sensitivity Level map. The Forest Service method is designed to produce a final map showing Visual Quality Objectives and recommends the management methods which will accomplish these objectives. In this study the Quality Objectives have been changed to Sensitivity Classes, as shown in Table III F-5, in order that the final map may be more easily used to consider scenic values in the planning of development. A matrix developed by the Forest Service was used to arrive at the Sensitivity Class map. This matrix is shown in Table III F-6; its function is to integrate the Variety Classes with the Distance Zones/Sensitivity Levels to arrive at the Sensitivity Classes. The map of Sensitivity Classes (Figure III F-11) depicts the baseline scenic quality of the intensive study area. Guidelines for visual management of these Sensitivity Classes are discussed below.

VISUAL MANAGEMENT GUIDELINES

The Forest Service has developed management guidelines for retaining the scenic quality of lands under its control. The C-b Shale Oil Project will make use of these same visual management guidelines in all planning, construction, reclamation and mining operations. In the event that development activities must take place in areas of relatively great visual sensitivity, these activities will be designed to minimize, to the extent possible, the visual impact of the activity. The level of visual sensitivity of the affected area will be a factor determining the degree of design modification necessary to minimize visual impact. The visual management guidelines for each Sensitivity Class are given below:

TABLE III F-4

DISTANCE ZONE CRITERIA

	Foreground	Midground	Background
Distance (miles)	0 to 1/4-1/2	1/4-1/2 to 3-5	3-5 miles to infinity
Sight capacity	Detail ⟷		No detail
Object viewed (example)	Rock point	Entire ridge	System of ridges
Visual characteristics	Individual plants & species	Texture and Form (conifers/ hardwoods)	Patterns (light and dark)

DISTANCE ZONES/SENSITIVITY LEVELS COMPOSITE

SCALE

½ 0 1 MILE

Fg1 / Fg2 > FOREGROUND (SENSITIVITY LEVELS 1 & 2)

Mg1 / Mg2 > MIDGROUND (SENSITIVITY LEVELS 1 & 2)

Bg1 / Bg2 > BACKGROUND (SENSITIVITY LEVELS 1 & 2)

NS NOT SEEN

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Figure III F-10

TABLE III F-5

SENSITIVE AREAS - QUALITY OBJECTIVES COMPARISON

Sensitivity Class	USFS Visual Quality Objective	Degree of Acceptable Change
A	Retention	Should not be evident
B	Partial Retention	Should be visually subordinate
C	Modification	May be visually dominant but must possess visual characteristics of natural landscape.
D	Maximum Modification	May be visually dominant but must possess visual characteristics of natural landscape when viewed as background.

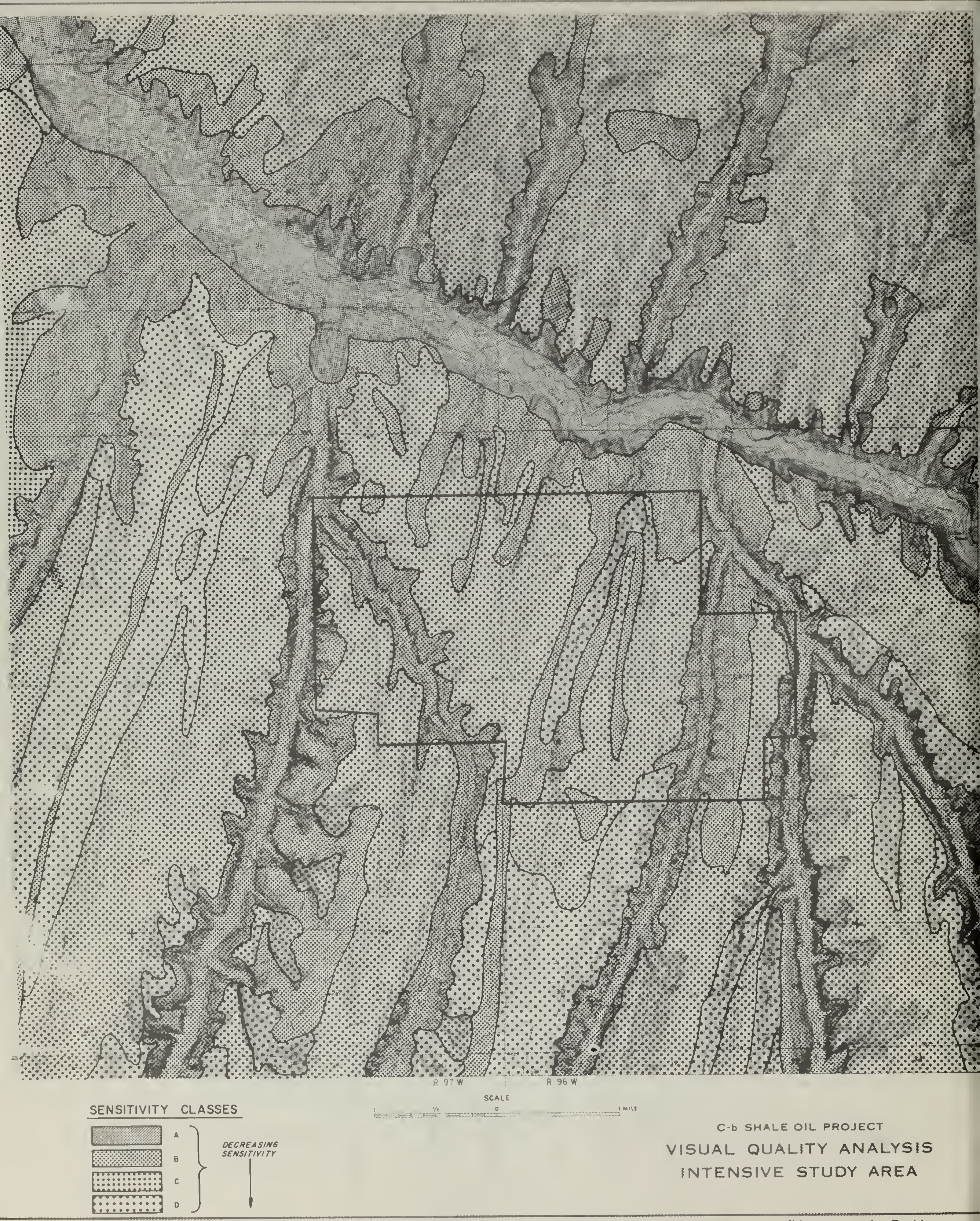
TABLE III F-6

SENSITIVITY CLASS MATRIX *

Variety Class	Distance Zone/Viewer Sensitivity Level						
	Foreground, level 1	Midground, level 1	Background, level 1	Foreground, level 2	Midground, level 2	Background, level 2	Not Seen level 3
Distinctive	A	A	A	B	B	B	B
Common	A	B	B	B	C	C	D
Minimal	B	B	C	C	C	D	D

*Sensitivity Classes

A
B ↓ Decreasing Sensitivity
C
D



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VISUAL QUALITY ANALYSIS
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Figure III F-11

Class A

Development activities may only repeat form, line, color, and texture which are frequently found in the landscape. Changes in their size, amount, intensity, direction, pattern, etc., should not be evident. Reduction in contrasts of form, line, color, and texture due to development should be initiated either during construction or immediately thereafter. It may be done by such means as seeding vegetation clearings and cut-and-fill slopes, hand planting large plant stock, or painting structures.

Class B

Development activities may repeat form, line, color, or texture common to the landscape, but changes in size, amount, intensity, direction, pattern, etc., should remain visually subordinate to the landscape. Activities may also introduce form, line, color, or texture which are found infrequently or not at all in the landscape, but they should remain subordinate to the visual strength of the landscape. Reduction in contrasts of form, line, color, and texture due to development should proceed as soon after construction as possible, but no more than one year later.

Class C

Development activities may visually dominate the original landscape; however, activities of vegetative and landform alteration must borrow from naturally established form, line, color and texture so completely and at such a scale that their visual characteristics are those of the natural landscape. Additional parts of these activities such as structures and roads must remain visually subordinate to the proposed composition. Activities which are predominately introduction of facilities such as buildings, signs, roads, etc., should borrow from the existing form, line, color, and texture so completely and at such a scale that their visual character is compatible with the natural landscape. Reduction in contrasts of form, line, color, and texture owing to development should be initiated in the first year or at a minimum should meet any existing regional guidelines.

Class D

Developemnt activities may dominate the landscape; however, when viewed as background, the visual characteristics must be those of the natural landscape. When viewed as foreground or midground, they need not borrow from the natural form, line, color, and texture. Alterations may also be out of scale or contain incongruent detail when viewed as foreground or midground. Introduction of additional parts of these activities such as structures and roads must remain visually subordinate when viewed as background. Reduction of contrast in form, line, color, and texture due to development should proceed within five years.

SUMMARY

The Piceance Basin was found to have low scenic value when compared to the other landscape types of the region. It contains marginal strength of form and line when compared to nearby western Colorado areas such as the Book Cliffs, Roan Cliffs, Grand Mesa, and the Flattops. It rates about equally with these other types with regard to color and texture. On a regional (much less a national) basis the Piceance Basin has an extremely low degree of visual variety. It should be noted, however, that this lack of variety results in a landscape in which smaller degrees of change are more obvious than they might be in an area which was less uniform.

In the intensive study area surrounding Tract C-b, the scenic resources were evaluated solely within the context of the Piceance Basin itself. A four-level rating scale (Sensitivity Classes A, B, C, and D) was developed based on the U. S. Forest Service Visual Management System. Class C, B, and A areas are, progressively, more sensitive than Class D areas. Within the context of the Piceance Basin proper, the only Class A area near Tract C-b is the Piceance Creek Road corridor. Most of the Tract is located on areas determined to be of Sensitivity Classes B and C. The Sensitivity Class B areas include the principal drainages cutting through the Tract. The Class C areas comprise the chained regions which cover more than half of the Tract. The only Class D area on Tract exists at the bottom of Sorghum Gulch. It was so rated because it is not visible from any User Area.

The assumptions made in this study were designed to maximize the scenic values which do exist in the Piceance Basin. It was stated earlier that these values are in fact marginal when compared to those existing in contiguous areas of western Colorado. The final map of Sensitivity Classes is also a liberal interpretation of the Piceance Basin's scenic values for the reason that most users' cone-of-vision does <u>not</u> expose them to many of the side gulches which contain the Basin's distinctive landscapes. This was most evident to the two field investigators who had considerable familiarity with the area, but who discovered a number of visually attractive areas solely as a result of this study.

It should be emphasized that this methodology primarily accounts for scenic qualities seen by the <u>majority</u> of Basin users. It does not account for small, isolated areas that the individual hiker or hunter may encounter when traveling off established travel routes. Such areas are subject to extremely individual preferences that no methodology designed to study regional scenic values can accommodate.

In its consideration of scenic resources, the C-b Shale Oil Project will utilize the Sensitivity Class map and guidelines on an in-house basis to plan for routine development activities such as road improvements, drill pads, and minor clearing. In order to take scenic resources into consideration, when major development activities such as plant siting and processed shale disposal are in the planning and construction stages, it may be necessary to acquire outside professional assistance. The design of major facilities to attempt to conform with the Visual Quality Objectives corresponding to the sensitivity level of the proposed site location will also require professional guidance.

CITATIONS

Fenneman, Nevin M. 1931. Physiography of the Western United States. New York and London: McGraw-Hill Book Company.

United States Forest Service. 1974. National Forest Landscape Management, Vol. 2.: Chapter 1 - The Visual Management System. USDA Agricultural Handbook No. 462. 47 pp.

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